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Naval Weapons Station Seal Beach, Detachment Concord
Concord, California

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FINAL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
FOR
LITIGATION AREA
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

GSA.105.00006

June 30, 2003

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ACRONYMS AND ABBREVIATIONS

AA	Allied Site A
AB	Allied Site B
ACCI	ASRC Contracting Company, Inc
AOC1	Area of Concern 1
ARAR	Applicable or relevant and appropriate requirement
ATSF	Atchison, Topeka, and Santa Fe
AWQC	Ambient water quality criteria
BAF	Bioaccumulation factor
BERA	Baseline ecological risk assessment
bgs	Below ground surface
CCR	*California Code of Regulations*
CCCMVAD	Contra Costa County Mosquito and Vector Abatement District
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action Navy
CNPS	California Native Plant Society
COC	Chemical of concern
COPEC	Chemical of potential ecological concern
CP	Coke pile site
CPC	Chemical and Pigment Company
CSM	Conceptual site model
CTR	California Toxics Rule
CWA	Clean Water Act
DDT	Dichlorodiphenyltrichloroethane
DL	Detection limit
DQO	Data quality objective
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
E&E	Ecology and Environment
EFA West	Naval Facilities Engineering Command, Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
ERA	Ecological risk assessment
ER-L	Effects-range low
ER-M	Effects-range median
$ER\text{-}M_q$	Effects-range median quotient
ESD	Explanation of significant difference

ACRONYMS AND ABBREVIATIONS (Continued)

FS	Feasibility study
FSP	Field sampling plan
G-1	G-1 area
GCC	General Chemical Corporation
GIS	Geographic information system
GPS	Global positioning system
GWF	G.W.F. Power Systems Company, Inc
HHRA	Human health risk assessment
HQ	Hazard quotient
HI	Hazard index
IAS	Initial assessment study
IT	International Technology Corporation
K-2	K-2 area
KS	Kiln Site
MASSA	Maximum allowable sewage sludge application
mg/kg	Milligram per kilogram
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mm	Millimeter
msl	Mean sea level
Navy	U.S. Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
ORNL	Oak Ridge National Laboratory
PCB	Polychlorinated biphenyl
ppm	Part per million
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QEA	Qualitative ecological assessment

ACRONYMS AND ABBREVIATIONS (Continued)

RAP	Remedial action plan
RASS	Remedial action subsite
RBC	Risk-based concentration
RCRA	Resource Recovery and Conservation Act
RI	Remedial investigation
ROD	Record of decision
RWQCB	California Regional Water Quality Control Board
SARAC	Statistically above reference area criteria
SBD	Seal Beach Detachment
SCS	U.S. Department of Agriculture Soil Conservation Service
SNR	Sacramento Northern Railroad
SOP	Standard operating procedure
SPTC	Southern Pacific Transportation Company
STLC	Soluble threshold limit concentration
SWRCB	State of California Water Resources Control Board
TBC	To be considered
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TRV	Toxicity reference value
TtEMI	Tetra Tech EM Inc.
TTLC	Total threshold limit concentration
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound
WES	USACE, Waterways Experiment Station
WCC	Wetland creation criteria
WCC-c	Wetland creation criteria for cover
WCC-nc	Wetland creation criteria for noncover
WSA	William Self Associates
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

The U.S. Department of the Navy (Navy) conducted the first post-remediation five-year periodic review assessment for the Litigation Area sites at Naval Weapons Station, Seal Beach Detachment (SBD) Concord, California. This five-year postremediation review is a statutory review required under the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act of 1986, in cases where (1) contaminants are left in place and (2) the record of decision (ROD) was signed after October 1986. The main purpose of the five-year review was to evaluate the implementation and the effectiveness of the selected remedy and to determine whether any additional actions are necessary. The specific objectives of the five-year review assessment were to determine (1) whether the remedy is functioning as intended under the ROD, (2) whether the assumptions made at the time of the remedy are still valid, and (3) whether any other information calls into question whether the remedy is protective of human health and the environment.

BACKGROUND

The Litigation Area sites are located in the Tidal Area; this property was acquired by the Navy in the 1970s from several different property owners. This area was subsequently found to be contaminated with metals resulting primarily from waste disposal activities and historic spills from off-site neighboring chemical companies; some smaller on-site historic (non-Navy) sources were also located in several parcels. The Navy did not conduct any activities in these parcels that contributed contamination. Four sites, known as remedial action subsites (RASS), were identified in a remedial investigation (RI) and feasibility study (FS) completed by the U.S. Army Corps of Engineers in 1988; the RI identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as chemicals of concern, and the FS recommended remedial alternatives and soil cleanup criteria for each RASS. On April 6, 1989, the Navy issued a final remedial action plan (RAP) and signed a ROD.

The remedy identified in the RAP and ROD included active removal of the most contaminated soil from a portion of each site and passive remediation and long-term monitoring of contaminants left in place. Because the Litigation Area includes wetlands that provide habitat for several threatened or endangered species, some contaminated soil was left in place to avoid destroying sensitive habitat. Active remediation (removal and disposal of contaminated soil) was conducted between 1992 and 1995; site revegetation was completed by 1996. The Navy implemented a monitoring plan as part of its remedial design to assess migration and effects of contaminants left in place. The Navy completed 5 years of postremediation monitoring before initiating the five-year review assessment.

COMPONENTS OF THE FIVE-YEAR REVIEW

The following table provides an overview of the five-year review:

Litigation Area, Naval Weapons Station, SBD Concord	
Lead Agency	Naval Facilities Engineering Command, Engineering Field Activity West (Stephen F. Tyahla, Remedial Project Manager)
Supporting Organizations	Tetra Tech EM Inc. and Uribe and Associates (contractors to the Navy)
Review Number	First Review
Review Type	Statutory
Trigger Action and Date	Remedial action construction and revegetation completed at all sites in June 1996
Operable Units	Four remedial action subsites (RASS): RASS 1, RASS 2, RASS 3 and RASS 4
Implementation Status	Construction complete: remedial actions and revegetation completed for all four RASSs; 5 years of postremedial action monitoring completed.

The components of the five-year review were developed in collaboration with the regulatory and trustee agencies and documented in a work plan. Compliance with the ROD and protectiveness of the remedy were evaluated in the five-year review. The Navy also agreed to conduct a screening-level human health risk assessment (HHRA) and a baseline ecological risk assessment (BERA) to evaluate whether metals contamination left at the site presents an ongoing threat. The following components formed the basis of the review:

- Review of site documents
- Site inspection tour
- Review of operations and maintenance costs
- Review of applicable or relevant and appropriate requirements (ARAR) and other guidance
- Review of monitoring objectives and results
- Evaluation of existing sources and migration of contaminants
- Screening-level HHRA
- BERA

The five-year review assessment was based on data collected during preremediation and postremediation monitoring, the qualitative ecological assessment (QEA) conducted from 1995 to 1997, and new data collected in October 2000 to fill data gaps identified during the development of the approach for the five-year review.

FINDINGS AND CONCLUSIONS OF THE FIVE-YEAR REVIEW

The following sections briefly summarize findings and conclusions of the five-year review.

Document Review

Documents about remedial decisions, design, and implementation were reviewed for information relevant to the assessment. The full extent of contamination may not have been known at the time the remedy was selected, since most early sampling focused on the eastern portion of the site. However, the extent of contamination was well characterized during postremediation monitoring. The same six metals identified in the RI (arsenic, cadmium, copper, lead, selenium, and zinc) are still considered to be the major risk drivers at the site based on results of the QEA and the five-year review assessment.

The Navy's remedial actions were selected and implemented in a manner consistent with the National Contingency Plan. The Navy established four specific objectives for remedial action, including:

1. Prevent biota from contacting contaminated soils that would threaten them
2. Prevent resuspension of contaminated sediments and soils in surface water and air and redistribution of contaminated sediments and soils, which would threaten flora and fauna in the area
3. Minimize disturbance to the wetlands consistent with long-term protection of flora and fauna
4. Prevent migration of contaminants into groundwater

The Navy selected total threshold limit concentration (TTLC), soluble threshold limit concentration (STLC), and statistically above reference area criteria (SARAC) values as cleanup criteria. To protect wetland habitat and special status species, these criteria were waived and no cleanup was conducted in some contaminated portions of the wetland in RASSs 1 and 2. The RAP and ROD identified the potential for additional remedial actions in the passive remediation areas if warranted in the future, but did not define triggers or decision criteria for when that additional remediation would be required.

Site Inspection Tour

The Navy, the contractors, and agency representatives made several important observations during the site inspection tour on July 27, 2001, and during subsequent visits in Fall 2001. These observations included:

- **Border of Chemical and Pigment Company (CPC) and Nichols Creek:** Observations were made during the five-year review that indicate a potential for contamination to migrate from CPC into Nichols Creek in RASS 3. Areas of soil erosion and surface water runoff exist at the CPC and Navy property border; plastic sheeting covering the large stockpile of contaminated soil at CPC was ripped, exposing contaminated soil to the weather. .

- **Erosional Areas along Nichols Creek:** Extensive erosion of potentially contaminated soil is occurring along Nichols Creek; the areas of greatest erosion occur on adjacent railroad property.

- **Railcar Spill between RASSs 2 and 3:** White powder was spilling from a parked railcar on the Atchinson Topeka Santa Fe rail spur. White powder was also observed along the railroad tracks leading to the General Chemical facility. Subsequent analysis of the powder indicated it was aluminum-based.

- **Area of Distressed Vegetation along Berm between General Chemical/Honeywell Facility and Navy Property:** An area of distressed and dead vegetation (approximately 10 feet by 160 feet) was present in the remediated area of RASS 1 adjacent to the berm. The cause of the distressed vegetation has not been determined; however, it may be related to chemical contamination migrating from neighboring chemical facilities.

- **RASS 4 Access Concerns:** Evidence of trespassers in RASS 4; one gate was broken, and motorcycle tracks were seen in RASS 4.

- **RASS 4 Semilithified Soil**: An unusual semilithified or ashy soil was present in RASS 4.

Operations and Maintenance Costs

The Navy has spent about $19 million on remediation, restoration, and monitoring activities at the Litigation Area.

Applicable or Relevant and Appropriate Requirements Review

ARARs were identified in the FS. The Navy identified TTLC, STLC, and SARAC as criteria for developing remediation goals to actively remediate heavily contaminated soils in each RASS. These criteria were met in areas actively remediated by the Navy. However, these criteria were not met in areas where the criteria were waived because of concerns about impacts to wetland habitat and special status species; no remediation was performed in these areas. Currently, concentrations of metals are still well

above the cleanup criteria in unremediated portions of the site. The Navy acknowledges that current guidelines support the use of risk assessment to help make decisions on protectiveness and cleanup goals for ecological and human receptors. Considering the refinement of risk assessment methodology and guidance since selection of the remedy in 1989, the Navy believes that TTLC and STLC criteria are no longer appropriate for assessing protectiveness or developing remediation goals. As a result, the Navy agreed to conduct a screening-level HHRA and a BERA during this five-year review period to evaluate whether areas actively remediated to TTLC and STLC levels and areas with contaminants left in place now pose an unacceptable risk to human or ecological receptors.

In addition, the Navy identified new Clean Water Act standards as relevant to protectiveness of the remedy. The Navy identified appropriate water quality screening values that are a combination of beneficial use designations in "The Basin Plan" for the San Francisco Bay Basin and U.S. Environmental Protection Agency ambient water quality criteria.

In accordance with federal and California Endangered Species Acts, three animal species with special status were considered during selection and implementation of the remedy (salt marsh harvest mouse [*Reithrodontomys raviventris*], California Clapper Rail [*Rallus longirostris obsoletus*], and California Least Tern [*Sterna antillarum*]). Based on numerous site-specific wildlife surveys, the clapper rail and the least tern are not considered by the Navy to inhabit the site. Since other threatened or endangered species have been observed at the site or have been given special status since 1989, the protectiveness of the remedy was evaluated in light of this new information.

Monitoring Program

The Navy completed preremediation (during remediation) and 5 years of intensive postremediation monitoring, as required by the ROD. The monitoring program design was revised between the preremediation and postremediation periods to better address concerns at the site; this redesign limited the comparison of some types of preremediation and postremediation data. The monitoring program included chemical analysis (soil, sediment, and surface water), ecological surveys (vegetation, small mammals, and rails), and evaluation of the success of the restoration efforts in remediated areas. Data collected during the five-year monitoring program were sufficient to fulfill the monitoring objectives and provided information that will focus future efforts at the site.

Statistical and graphical evaluations were used to identify changes or trends in concentrations of metals at the scale of the spatial unit. While high temporal and spatial variability existed in chemical concentrations, there was little indication of significant changes in metals concentrations in unremediated

portions of the site. Based on monitoring program results, remediated areas in RASSs 1, 2, and 4 are not becoming recontaminated. However, erosion of Nichols Creek and upgradient neighboring sources may be affecting chemical concentrations in RASS 3. The area in RASS 1 along the berm adjacent to the General Chemical facility may be impacted by contamination from the adjoining property.

The Navy also conducted numerous special studies to evaluate potential migration of contaminants during storm events and net flux of dissolved metals and suspended sediment entering and leaving the site during incoming and outgoing tides. These studies showed little migration of contaminants to the Bay, but did indicate potential uncontrolled migration within ditches and sloughs in southern RASS 1 and in Nichols Creek.

No specific goals were set as a measure of habitat quality, but ecological surveys indicated the continued presence and use of the site by special status plants and animals; most populations of special status species were stable or increased over the 5 years of postremediation monitoring. Some special status plant and animal species have recolonized the remediated area in RASS 1.

Results of revegetation surveys evaluated in comparison with specific success criteria indicated that most revegetation efforts were very successful; however, a few areas exist in RASSs 2 and 4 where revegetation success criteria were not met.

Existing Sources and Contaminant Migration

The five-year review included an evaluation of existing data to identify on-site and off-site sources of contamination that may be migrating. The State of California has documented and the Navy file review has supported the idea that the abandoned CPC facility and the operating General Chemical Company facility currently have high levels of contaminants remaining on their properties. In addition, the State of California has stated that a high potential exists for off-site migration from the CPC facility. Since the Navy's property is downgradient from CPC, a high potential exists that migration of metals from CPC may affect Navy property.

Nichols Creek in RASS 3 is an area of uncontrolled migration of contaminants in soil and surface water because the creek is actively eroding areas of contaminated soil; the areas of most extensive erosion are on railroad-owned properties. In addition, the CPC facility is upgradient and is likely to be contributing contaminated surface runoff and groundwater to Nichols Creek.

Contaminants on the marsh surface are being buried by cleaner sediment; the highest metal concentrations were detected at 3 to 5 inches below ground surface. The presence of dense vegetation on the marsh

surface and vertical profiles of contamination indicate that little migration of contaminants from the marsh surface is occurring.

Uncontrolled migration of contaminants in the ditch and slough bottom sediments may occur, since vertical profiles indicate areas of sediment erosion and accumulation. Little evidence exists that contaminated sediments are migrating all the way out of Lost Slough to Suisun Bay because tidal water quality sampling does not indicate that the site is exporting significant amounts of contaminants through the surface water pathway.

Groundwater flow rates are very slow so discharge to surface water bodies is likely to be very limited. As a result, groundwater contamination does not appear to pose a major problem in the Litigation Area marsh. However, high concentrations of metals in groundwater at the neighboring, upgradient CPC facility may migrate into the Litigation Area through the perched zone or discharge into Nichols Creek. In addition, contaminated groundwater from the General Chemical/Honeywell facility adjoining RASS 1 may be a continuing source of contaminants to the wetland.

Human Health Risk Assessment

The site is currently used as buffer zone, and access is limited to occasional entry by Navy personnel and approved workers. A two-tiered screening-level HHRA was conducted. The first tier evaluated the site using a scenario of future residential and commercial land use; this scenario is very unlikely and was evaluated only as a point of reference. The second tier used a more realistic scenario of access to the site by a representative receptor, a mosquito abatement worker.

Under the assumption that land use changes in the future, estimated cancer risks and noncancer hazard indices (HI) for a resident and a commercial/industrial worker exceed risk management levels considered protective of human health in some areas of each of RASSs 1 through 4.

Under the assumption that current land-use and site conditions remain unchanged, estimated cancer risks and noncancer HIs for current receptors, as represented by the mosquito abatement worker, are within or less than risk management levels. These risk findings indicate that current environmental conditions at the Litigation Area do not pose an unacceptable risk to human health based on the continued use of this area as a buffer zone with restricted access. Recent evidence of trespassers in RASS 4 indicates that existing access controls are inadequate. As a result, access controls should be improved.

Ecological Risk Assessment

A BERA was conducted as part of the five-year review. Multiple lines of evidence were used to assess and to characterize risk to plants, fish and aquatic invertebrates, and birds and mammals.

Concentrations of metals in soil and sediment at selected areas of the site may pose unacceptable risk to individual plants for some species; however, unacceptable risk is not indicated at the population level for wetland or upland plant species at the Litigation Area. No indication exists of an unacceptable risk to special status plants across the site.

Population-level effects to fish and aquatic invertebrates from exposure to dichlorodiphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCB) and Aroclors in sediment at the Litigation Area are not indicated. Elevated concentrations of metals in sediment and surface water may pose some unacceptable risk to populations of fish and aquatic invertebrates at selected locations in the main reach (Unit 10) and western arm (Unit 11) of Lost Slough on the basis of some observed toxicity in bioassays, levels of bioaccumulation, and comparison of chemical concentrations with available benchmarks.

Population-level effects to birds and mammals from exposure to DDTs, PCBs, and Aroclors in sediment and soil at the Litigation Area are not indicated. Some unacceptable risk from exposure to metals may exist for populations of the California Black Rail (*Laterallus jamaicensis coturniculus*) (risk driver is zinc) and the Suisun Song Sparrow (*Melospiza melodia maxillaris*) (risk driver is selenium) along areas of the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and in the ditches in Unit 5 and Unit 7. Population-level effects were not indicated for the salt marsh harvest mouse at the site. However, some unacceptable risk was indicated for individual salt marsh harvest mice from arsenic at a small number of locations in Unit 6. The Navy based its risk estimates for the salt marsh harvest mouse at point locations on maximum concentrations in 6-inch vertical composite cores. This assumption is likely to overestimate risk. The Navy determined that the exposure potential for the salt marsh harvest mouse was low based on a detailed analysis of vertical profiles. This analysis indicated higher contaminant concentrations are buried several inches below cleaner soil that has accreted on the marsh surface.

IDENTIFICATION OF DEFICIENCIES OF THE REMEDY

The deficiencies of the remedy that currently prevent the response action from being protective or have the potential to do so in the future include:

- **Presence of Ongoing Off-Site Sources**: Neighboring properties may be ongoing sources of contaminants to the Litigation Area. Given the physical evidence suggesting ongoing off-site sources, the Navy is doubts its ability to protect human health and the environment, meet ARARs, or provide long-term protection for the site. The potentially responsible parties must address these off-site sources to ensure protectiveness of the remedy.

- **Uncontrolled Soil Erosion in RASS 3**: Metals detected at high concentrations in soil or sediment at some locations in RASS 3 are a potential on-site source of contamination to the wetland in RASS 1. Uncontrolled migration, resulting from soil erosion along Nichols Creek in RASS 3, may mobilize and spread contaminants into the wetland habitat in RASS 1. The two major erosional areas are on railroad property and are not the responsibility of the Navy.

- **Uncontrolled Migration and Ecological Risk in Selected Ditches and Sloughs in Southern RASS 1**: High concentrations and uncontrolled migration of metals in ditches and sloughs in the southern portion of RASS 1 may pose a risk to ecological receptors at the site because metals become more bioavailable when mobilized. Therefore, metals in sediment collected from some of the ditches and sloughs in RASS 1 (Units 7, 10, and 11) remain a significant on-site source that poses some risk to fish and invertebrates and the California Black Rail.

- **Inadequate Access Controls in RASS 4**: During the site inspection tour in July 2001, evidence was observed that trespassers have gained access to RASS 4. The site is not fenced on the northern side, locks on the gates were broken open, and motorcycle tracks and refuse dumping were observed within RASS 4.

The following data gaps were also identified:

- **Distressed Vegetation in RASS 1:** The cause of distressed and dead vegetation in the remediated portion of RASS 1 along the border of the chemical companies has not been determined; however, the cause could be related to contaminant migration from the neighboring facilities. The preliminary file review documented high concentrations of metals and low pH in groundwater at the General Chemical facility.

- **Groundwater-Surface Water Interactions at the CPC Border:** The extent of groundwater-surface water interaction at the CPC and Nichols Creek border on Navy property is not known; the preliminary file review documented extremely high metals concentrations in groundwater beneath the CPC facility, which lies upgradient to the Litigation Area.

- **Litigation Area Groundwater Well Sampling**: The groundwater wells at the Litigation Area have not been sampled since 1996, and the current condition of groundwater quality is not known.

- **RASS 3 PCB Sampling:** A small area in RASS 3 adjacent to the railroad tracks and along Nichols Creek has not been adequately characterized for PCBs.

- **RASS 4 Semilithified Soil:** Unusual semilithified or ashy soil was observed in RASS 4. The chemical composition of this soil material is not known.

PROTECTIVENESS STATEMENTS

The remedy was not considered protective if (1) an immediate threat is present or (2) migration of contaminants is uncontrolled. The protectiveness statements for each RASS in the Litigation Area are identified as follows:

A. **RASS 1:** The remedy at RASS 1 is not protective of the environment because uncontrolled migration of contaminants exists in the ditches and sloughs in the southern portion of RASS 1 (Units 7, 10, and 11) and some risk exists to fish, invertebrates, and California Black Rails from contaminants remaining in these spatial units. No unacceptable risk exists to humans in RASS 1 under current land use.

B. **RASS 2:** The remedy at RASS 2 is protective of human health and the environment.

C. **RASS 3:** The remedy at RASS 3 is not protective of the environment, because uncontrolled migration of contaminants still occurs in Nichols Creek and risk remains to ecological receptors from contaminants that migrate from RASS 3 to the RASS 1 wetland. No unacceptable risk exists to humans in RASS 3 under current land use.

D. **RASS 4:** The remedy at RASS 4 is protective of human health and the environment; better access controls will be implemented to prevent trespass.

RECOMMENDATIONS

The following preliminary recommendations were made to address deficiencies, data gaps, or other outstanding concerns identified in the five-year review. Section 10.0 presents the recommendations and follow-up actions. The Navy acknowledges that the remedy is not fully protective of the environment in RASSs 1 and 3. However, evidence exists that the adjoining chemical company and railroad properties may be ongoing sources of contamination to RASSs 1 and 3. The Navy doubts its ability to meet ARARs, protect human health and the environment, and provide long-term protection for the site if there are significant ongoing off-site sources of contamination. Long-term protectiveness requires that both off-site sources and on-site areas that pose a risk are addressed. Therefore, long-term protectiveness requires the participation of adjoining property owners and regulatory agencies to address the off-site concerns.

The Navy proposes conducting additional investigations to further assess the significance of ongoing off-site sources and to resolve any on-site data gaps. The Navy's approach will be to conduct a data gaps evaluation and work with the regulatory agencies, the adjoining property owners, and, if necessary, the U.S. Department of Justice to address upgradient off-site sources. In addition, the Navy will conduct supplemental feasibility study that will evaluate alternatives to ensure protectiveness of the remedy in

downgradient portions of the site, specifically in Unit 7 mosquito ditches and Unit 11 slough in RASS 1, and the Unit 13 Nichols Creek area in RASS 3.

Recommendations for Future Monitoring Efforts

Because outstanding concerns still exist for the site, the Navy proposes to (1) collect additional data in focused studies to address data gaps and (2) conduct follow-on supplemental feasibility study to address portions of the site that are not protective. The Navy also plans to conduct limited monitoring of site conditions. The Navy recommends the following actions be implemented for future monitoring:

- Conduct periodic monitoring
- Focus monitoring objectives
- Utilize the data quality objective process
- Focus monitoring efforts on areas of concern
- Clearly identify temporal scope
- Link monitoring to risk-based questions
- Consider spatial variability of chemical concentrations in design
- Clearly identify trigger levels

Recommendations for Additional Sampling to Address Data Gaps

To address the data gaps identified at the site and to further evaluate potential off-site sources, the Navy is proposing additional investigations in the following areas:

- Sample soil and groundwater in the area of distressed vegetation in RASS 1 and review files on neighboring companies to determine whether chemical contamination is causing the observed effects to vegetation
- Establish and sample new groundwater wells on the border of CPC to evaluate groundwater-surface water interactions and the potential for migration of contaminants into Nichols Creek
- Sample all existing groundwater wells at the Litigation Area for metals to evaluate current conditions of groundwater
- Sample soil along the railroad track and Nichols Creek in RASS 3 to better characterize the spatial distribution of PCBs
- Sample semilithified soil in RASS 4 to determine the chemical composition of unusual soils

Recommendations to Protect Human Health and the Environment

The Navy proposes the following actions to address outstanding concerns about the remedy not being fully protective:

- Maintain measures to control access to RASSs 1, 2 and 3
- Improve measures to control access to RASS 4 to prevent trespass
- Conduct a supplemental feasibility study for the mosquito ditches in Unit 7 of RASS 1 to address uncontrolled migration of contaminants and to evaluate remedial alternatives
- Conduct a supplemental feasibility study for the western arm of Lost Slough (Unit 11) in RASS 1 to address ecological risk and uncontrolled migration of contaminants and to evaluate remedial alternatives
- Conduct a supplemental feasibility study for the erosional areas along Nichols Creek in RASS 3 to address uncontrolled soil erosion and to evaluate remedial alternatives.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site name: Remedial Action Subsite 1, 2, 3 and 4; Litigation Area, Naval Weapons Station Seal Beach Detachment Concord		
EPA ID: Not applicable		
Region: 9	**State:** CA	**City/County:** Contra Costa County
SITE STATUS		
NPL Status: ☒ Final ☐ Deleted ☐ Other		
Remediation status (choose all that apply): ☐ Under Construction ☐ Operating ☒ Complete		
Multiple OUs?* ☒ Yes ☐ No	**Construction completion date:** Fiscal Year 1996	
Has site been put into reuse? ☐ Yes ☒ No		
REVIEW STATUS		
Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency U.S. Navy		
Author name: Mary Gleason, Ph.D.		
Author title: Project Manager	**Author affiliation:** Tetra Tech EM Inc.	
Review period:** October 2000 to April 2002		
Dates of site inspection: 07 / 27 / 01		
Type of review: ☒ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion		
Review number: ☒ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify)		
Triggering action: ☐ Actual RA On-site Construction ☐ Actual RA Start at OU # __ ☒ Construction Completion ☐ Previous Five-Year Review Report ☒ Other (specify) Completed revegetation and 5 years of post-remediation monitoring		
Triggering action date: 08 /1996		
Due date *(five years after triggering action date)*: 08 /2001		

* [“OU” refers to operable unit].
** [Review period should correspond to the actual start and end dates of the Five-year Review.]

FIVE-YEAR REVIEW SUMMARY FORM (Continued)

Issues

The Navy and the regulatory agencies identified several issues during the review or site inspection tour that affect the protectiveness of the remedy. The following deficiencies prevent the response action from being protective or have the potential to do so in the future:

1. Presence of ongoing off-site sources at neighboring chemical company and railroad company properties
2. Uncontrolled soil erosion along Nichols Creek in RASS 3
3. Uncontrolled migration and ecological risk in some mosquito ditches (Unit 7) and a tidal slough (Unit 11) in the southern portion of RASS 1
4. Inadequate access controls in RASS 4.

In addition, the Navy and the regulatory agencies identified the following five data gaps during the review:

1. Cause of distressed and dead vegetation in the remediated portion of RASS 1 adjacent to the chemical companies
2. Groundwater-surface water interactions at the Chemical and Pigment Company border with Nichols Creek and the potential for contaminant migration from the adjacent property onto Navy property
3. Current condition of groundwater at the Litigation Area
4. Characterization of PCBs along the railroad track in RASS 3
5. Chemical composition of semilithified or ashy soils in RASS 4

Recommendations and Follow-up Actions

The Navy doubts its ability to meet ARARs, protect human health and the environment, and provide long-term protection for the site if there are significant ongoing off-site sources of contamination. As a result, the Navy proposes to conduct additional investigations to further evaluate ongoing, off-site sources and to resolve any on-site data gaps. The Navy's approach will be to conduct a data gaps evaluation and work with the regulatory agencies, the adjoining property owners, and, if necessary, the U.S. Department of Justice to address upgradient off-site sources. The Navy will also conduct supplemental feasibility study that will evaluate alternatives to ensure protectiveness of the remedy in downgradient portions of the site.

The Navy has also made the following recommendations:

- Conduct focused periodic monitoring; design future monitoring in collaboration with the regulatory and trustee agencies and using the data quality objective process (described in Section 10.1).
- Collect additional data to address the five data gaps identified (described in Section 10.2).
- Maintain measures to control access to RASSs 1, 2, and 3 and improve measures to control access to RASS 4 to prevent or alleviate trespass.
- Conduct supplemental feasibility study to evaluate alternatives to (1) reduce or eliminate mobilization of contaminated sediments in the mosquito ditches in Unit 7, (2) reduce ecological risk and reduce or eliminate mobilization of contaminated sediments in the tidal slough in Unit 11, and (3) prevent or decrease soil erosion along the creek bed and banks of Nichols Creek in RASS 3. Additional remedial or removal actions would only be conducted after the Navy determines that significant off-site sources have been addressed to ensure that Navy property will not be re-contaminated.

Protectiveness Statements

The remedy was not considered protective if (1) an immediate threat is present or (2) migration of contaminants is uncontrolled. The Navy identified the following protectiveness statements for each RASS in the Litigation Area:

- **RASS 1:** The remedy at RASS 1 is not protective of the environment because uncontrolled migration of contaminants exists in the ditches and sloughs in the southern portion of RASS 1 (Units 7, 10, and 11) and some risk exists to fish, invertebrates, and California Black Rails from contaminants remaining in these spatial units. No unacceptable risk exists to humans in RASS 1 under current land use.
- **RASS 2:** The remedy at RASS 2 is protective of human health and the environment.
- **RASS 3:** The remedy at RASS 3 is not protective of the environment, since uncontrolled migration of contaminants still occurs in Nichols Creek and risk remains to ecological receptors from contaminants that migrate from RASS 3 to the RASS 1 wetland. No unacceptable risk exists to humans in RASS 3 under current land use.
- **RASS 4:** The remedy at RASS 4 is protective of human health and the environment; however, better access controls will be implemented to prevent trespass.

Long-term Protectiveness

The Navy doubts its ability to achieve long-term protectiveness if there are ongoing off-site sources of contamination. Long-term protectiveness requires that both off-site sources and on-site areas that pose a risk are addressed. Therefore, long-term protectiveness requires the participation of adjoining property owners and regulatory agencies to address off-site concerns.

On the Navy's part, long-term protectiveness of the remedy will be achieved through focused studies to address data gaps, supplemental feasibility study to evaluate additional remedial alternatives, periodic monitoring, and the 5-year review process.

Other Comments

The Navy will work with the regulatory agencies and neighboring property owners to address concerns about ongoing off-site sources.

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Engineering Field Activity West (EFA West) conducted the first postremediation five-year periodic review assessment at the Litigation Area sites at Naval Weapons Station, Seal Beach Detachment (SBD) Concord (Figure 1). The Navy has authorized Tetra Tech EM Inc (TtEMI), formerly PRC Environmental Management, Inc. (PRC), to conduct the five-year assessment review under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract No. N62474-94-D-7609, Contract Task Order No. 373.

This five-year review follows remediation; this is a statutory review required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, in cases where (1) contaminants are left in place and (2) the record of decision (ROD) was signed after October 1986. The Navy's five-year review policy (Navy 2001) and U.S. Environmental Protection Agency (EPA) guidance (EPA 2001) were used to develop the five-year periodic review assessment report.

The main purpose of the five-year review was to evaluate the implementation and the effectiveness of the selected remedy and to determine whether any additional actions are necessary. The five-year review did not reconsider decisions made during selection of the remedy. The specific objectives of the five-year review assessment were to determine (1) whether the remedy is functioning as intended under the ROD, (2) whether the assumptions made at the time of the remedy are still valid, and (3) whether any other information calls into question whether the remedy is protective of human health and the environment.

The sites under review include property purchased by the Navy in the 1960s and 1970s to create a buffer zone around munitions loading activities. These sites were later found to be contaminated; subsequent litigation with the prior owners resulted in a settlement, and the sites became known as the Litigation Area.

The U.S. Army Corps of Engineers (USACE) Waterways Experiment Station (WES) conducted the remedial investigation (RI) and feasibility study (FS) for the Navy. The RI completed for the Litigation Area in 1988 identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as chemicals of concern (COC) (Lee and others 1986, 1988a). The final FS submitted in September 1988 identified recommended remedial alternatives and soil cleanup criteria for each site in the Litigation Area (Cullinane and others 1988). On April 6, 1989, the Navy issued a final remedial action plan (RAP) (Navy 1989a) and signed a ROD (Navy 1989b) for remediation of sites at the Litigation Area that were contaminated with metals.

The remedy identified in the RAP and ROD for the Litigation Area included active removal of the most contaminated soil from a portion of each site and passive remediation and long-term monitoring of contaminants left in place (Navy 1989a, 1989b). Between 1992 and 1995, the Navy completed four remedial actions to remove contaminated soil at the Litigation Area. The four sites that were cleaned up are referred to as remedial action subsites (RASS). The most contaminated soil was removed during the remedial actions from active remediation areas in each RASS. Because the Litigation Area includes wetlands that provide habitat for several threatened and endangered species, contaminated soil was left in place at portions of the site to avoid destroying sensitive wetland habitat. The RAP required intensive monitoring of the passive remediation and monitoring areas to evaluate whether contaminants left in place were migrating or causing adverse ecological effects.

To assess the effects and potential migration of contaminated soil that was left in place and to evaluate the success of the remedial actions, the Navy developed a monitoring plan as part of its remedial design. The "Monitoring Plan for Contamination Remediation at Naval Weapons Station, Concord, California" was prepared for the Navy by WES (Lee and others 1989a); monitoring was conducted by the Navy's contractors. The monitoring plan required monitoring before, during, and after remediation. Preremediation chemical and biological data collected in 1991 were reported in the baseline conditions report (PRC 1994a). The monitoring plan has been implemented annually from 1996 to 2000, with some significant modifications (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a).

In addition, the Navy conducted a qualitative ecological assessment (QEA) from 1995 through 1997 to evaluate risk to ecological receptors posed by chemicals at the Litigation Area (PRC 1997c). The goals of the QEA were to (1) validate that remediation had successfully reduced ecological risks to acceptable levels and (2) evaluate whether the six metals included in the monitoring program (arsenic, cadmium, copper, lead, selenium, and zinc) were the only COCs at the site. The results of the QEA indicated that some ecological risk remained in unremediated areas of the site and that the six metals from the monitoring program were identified as the primary risk drivers. A human health risk assessment (HHRA) was not conducted at the Litigation Area during the RI.

The following table provides an overview of the five-year review:

Litigation Area, Naval Weapons Station SBD Concord	
Lead Agency	Naval Facilities Engineering Command, Engineering Field Activity West (Stephen F. Tyahla, Remedial Project Manager)
Supporting Organizations	Tetra Tech EM Inc. and Uribe and Associates
Review Number	First Review
Review Type	Statutory
Trigger Action and Date	Remedial action construction completed at all sites in June 1996
Operable Units	Four remedial action subsites (RASS): RASS 1, RASS 2, RASS 3 and RASS 4
Implementation Status	Construction complete: remedial actions and revegetation completed for all four RASSs; 5 years of postremedial action monitoring completed.

1.1 SCOPE OF THE FIVE-YEAR REVIEW

The scope of the five-year periodic review assessment and the approach taken to evaluate the protectiveness of the remedies selected was determined in consultation with the regulatory and trustee agencies. The five-year review includes an assessment of the success and protectiveness of the remedy and addresses concerns about contaminant migration and risk at the site. The Navy agreed to fill several data gaps through additional field investigations and data evaluation as part of the five-year review process, rather than identify deficiencies to be addressed at a later date. The overall approach to the five-year review assessment was described in the draft final work plan for the five-year periodic review assessment (TtEMI 2000d), which included a field sampling plan (FSP) (TtEMI 2000b) and a quality assurance project plan (QAPP) (TtEMI 2000c) that detailed the collection of new data in October 2000.

As part of the five-year review process, the Navy (1) summarized the results of the monitoring program, (2) evaluated existing sources and migration of contaminants, (3) conducted a screening-level HHRA, and (4) conducted a focused baseline ecological risk assessment (BERA). Results of those efforts are summarized in this report (Section 6.0), and the complete results are included as appendices.

1.2 SITES INCLUDED IN THE FIVE-YEAR REVIEW

The five-year review includes four RASSs that comprise the Litigation Area (Figure 2). Recommendations and conclusions will be made separately for each RASS, when possible. The four RASSs are briefly described below and are further described in Section 3.0:

- RASS 1 comprises 210 acres of brackish marsh on the edge of Suisun Bay; the marsh has a meandering tidal slough and numerous manmade mosquito ditches.

- RASS 2 comprises 13 acres of brackish marsh, upland, and wetland-upland transitional habitat, just south of RASS 1.

- RASS 3 comprises 71 acres of disturbed grassland, with a small tidally influenced marsh and a seasonal creek.

- RASS 4 comprises 13 acres of disturbed grassland, with scattered coyote brush (*Baccharis pilularis*) and a small freshwater marsh.

1.3 REPORT ORGANIZATION

The five-year periodic review assessment report is organized as follows:

- Section 1.0 provides an overview of the document

- Section 2.0 includes a description of the site, including the physical and ecological setting.

- Section 3.0 provides a site chronology and history of contamination, early response and investigations, and a synopsis of the ROD and RAP.

- Section 4.0 describes the remedial actions and monitoring conducted to date.

- Section 5.0 presents the an overview of the components of the five-year review, including the five-year review team, community involvement activities, and a summary of data evaluated in the review.

- Section 6.0 presents the findings of the five-year review, including observations from the site tour, a review of changes in applicable or relevant and appropriate requirements (ARAR), a summary and evaluation of the monitoring program, an evaluation of ongoing sources and migration of contaminants, and results of the HHRA and BERA.

- Section 7.0 summarizes the results of the assessment of protectiveness of the remedy.

- Section 8.0 identifies deficiencies of the remedy and data gaps.

- Section 9.0 presents protectiveness statements for each RASS.

- Section 10.0 presents recommendations and follow-up actions for the site.

- Section 11.0 states when the next five-year review should take place.

- Section 12.0 includes other comments.

In addition, technical details supporting the conclusions can be found in the following appendices:

- Appendix A includes a list of site documents that were reviewed for this five-year review assessment report.
- Appendix B includes a site inspection checklist and photographs documenting current site conditions and potential off-site sources taken during the site tour held on July 27, 2001; a California Regional Water Quality Control Board (RWQCB) report on a chemical spill from an isolated railroad car; photographs taken during a follow-up visit; and a map showing the area of distressed vegetation in RASS 1.
- Appendix C presents the draft final community summary report (the draft report was submitted as a separate document on February 19, 2002).
- Appendix D summarizes the results of the monitoring program and includes an evaluation of the effectiveness of the monitoring program.
- Appendix E presents a technical evaluation of existing sources and migration of contaminants at the site.
- Appendix F describes the two-tiered screening-level HHRA that evaluates protectiveness of the remedy and risk to human receptors from remaining contaminants at the site.
- Appendix G includes the BERA that evaluates protectiveness of the remedy and risk to ecological receptors from remaining contaminants at the site.
- Appendix H includes the Navy's responses to regulatory agency comments on the draft and draft final versions, as well as meeting minutes and handouts from risk management meetings held in February and March 2002 and the dispute resolution meeting held in March 2003.

The five-year periodic review assessment report text, appendices, and tables (Tables 1 through 112) are included in Volume I. All of the figures supporting the five-year periodic review assessment (Figures 1 through 95) are provided in Volume II.

2.0 SITE DESCRIPTION AND PHYSICAL SETTING

The following sections describe the location, land use, and physical and ecological characteristics of the Litigation Area.

2.1 SITE LOCATION AND LAND USE

Naval Weapons Station SBD Concord is in north-central Contra Costa County, approximately 30 miles northeast of San Francisco, California (Figure 1). The Navy facility operates an ocean-shipping terminal to transfer ordnance from trucks or railcars to ships. The facility is bounded on the north by Suisun Bay, on the south and west by the city of Concord (population 121,000), and on the east by private land and the city of Pittsburg. It encompasses nearly 13,000 acres in three holdings: Inland Area, Tidal Area, and a radiography facility at Pittsburg, California. The Litigation Area is within the Tidal Area (Figure 2).

The Tidal Area is composed of property on the mainland (6,077 acres) and islands (1,571 acres). Piers and most other facilities in the Tidal Area are part of the original property of the Naval Magazine, Port Chicago. Approximately 3,230 acres in the Tidal Area are leased for agricultural purposes (International Technology Corporation [IT] 1989). In the late 1960s and early 1970s, the Navy purchased several parcels of land to create a buffer zone around the Tidal Area. Eight of those parcels, which cover a total of approximately 307 acres, were subsequently found to be contaminated. These parcels are now referred to as the Litigation Area (Figure 2) and were grouped into four RASSs during the RI and FS process (Section 3.0).

2.1.1 Historic Land Use

Historic changes in land use in the immediate vicinity of the Litigation Area were determined by reviewing historical maps and aerial photographs. In general, the wetland portion of the site has not changed or been developed since 1886. Portions of the upland area have been used for a variety of industrial uses as well as some livestock grazing. Industrial activity in the properties to the east of the Litigation Area began as early as 1905. Historic sources of contamination and development of neighboring industrial facilities are described in Section 3.1.

2.1.2 Current Land Use and Access Controls

The Litigation Area is currently used by the Navy as a buffer zone to ensure security for military operations. No buildings are on the site and the site consists of natural wetland and upland habitat. One

access road into RASS 3 is blocked and gated with a chain-link fence. Several railroad tracks traverse the site, and the railroads own right of ways that extend 50 feet on either side of the tracks.

Most of the Litigation Area lies within the "explosive arc" safety zone that is used to safeguard human life during the loading of ammunitions on ships docked at nearby piers in the Tidal Area. Access to the Litigation Area is limited to those personnel approved by the Navy and access is not allowed to most personnel during ship loading events. Regular security patrols and intermittent fencing in areas near roads limit trespassing.

No agricultural use or livestock grazing occurs in the Litigation Area. The Litigation Area groundwater supply is not considered potable, and groundwater does not flow in the direction of potable water supplies.

Suisun Bay and a group of islands containing marshlands and manmade levee are north of the Litigation Area. Suisun Bay is used by recreational and commercial watercraft. Port Chicago Highway lies just south of the Litigation Area. The area to the south of Port Chicago Highway includes the open grasslands of Los Medanos hills, which have been used in the recent past for cattle grazing.

The area to the west of the Litigation Area consists of undeveloped wetland, ship loading piers, and secure buildings for military operations. The eastern side of the Litigation Area is bordered by Nichols Road, the operational facilities of General Chemical Corporation (GCC) – Bay Point and G.W.F. Power Systems Company, Inc (GWF), and the nonoperational and abandoned Chemical and Pigment Company (CPC) (Figure 3). Those facilities are bordered to the east by a small housing development (Shore Acres) and McAvoy boat harbor. Even further east lies the city of Pittsburg and several industrial facilities.

2.1.3 Projected Future Land Use

Land use is expected to remain unchanged in the foreseeable future, with the Litigation Area remaining undeveloped land that provides a buffer zone for military activities such as ordnance loading. The Navy retains ownership of the Tidal Area (including the Litigation Area); however, as of 1999, an indefinite use permit has been issued that allows the U.S. Army to conduct operations in the area. The U.S. Army currently manages munitions and equipment loading activities. Real estate disposal or development of the land within the Litigation Area is not an option in any Navy plans.

2.2 PHYSICAL CHARACTERISTICS

Naval Weapons Station SBD Concord is approximately 10 miles west of the confluence of the Sacramento and San Joaquin Rivers. That confluence forms the delta region, which contains more than 600 miles of interconnected and meandering tidal waterways. Except for a few small streamways that drain west into San Francisco Bay, the drainage of Contra Costa County flows either north or west into the San Joaquin River, San Pablo Bay, or Suisun Bay. Drainage from Naval Weapons Station SBD Concord flows almost exclusively northward into Suisun Bay. The Litigation Area is comprised of upland and wetland habitats and is not currently developed.

RASS 1 is primarily a brackish, tidally influenced emergent marsh. The mean elevation of RASS 1 is 3 feet above mean sea level (msl). Wetland areas for RASSs 1 and 2 that were delineated by the USACE in 1991 were defined as those areas less than 5 feet in elevation (above msl). The elevation of RASS 1 is generally less than 5 feet, making the entire area a wetland. The marsh surface usually ranges from damp to dry; however, after extreme high tides or heavy rains, several inches to 2 feet of water are present throughout RASS 1. The RASS 1 marsh includes tidal slough channels and a network of manmade mosquito abatement ditches that transect the site.

RASS 2 consists of brackish, tidally influenced emergent marsh and an upland vegetation transition zone that extends south to the Southern Pacific Transportation Company (SPTC) railroad track. The northwestern portion of RASS 2 is a wetland with a mean elevation of approximately 3 feet above msl. The remaining portion of RASS 2 consists of relatively flat uplands with a mean elevation of approximately 7 feet above msl.

RASS 3 is primarily an upland area. A small area of robust, tidally influenced emergent marsh in the northwestern portion of RASS 3 was deepened and expanded during remediation activities to form a ponded area. Nichols Creek, an ephemeral stream, runs through RASS 3 to the newly created ponded area, subsequently draining into the extensive mosquito abatement ditch and slough system in RASS 1, which in turn discharges to Suisun Bay. The wetland area for RASS 3, delineated by the USACE in 1991, is roughly defined as the area encompassing the lower reaches of Nichols Creek and the ponded wetland, which corresponds with the remediated area of RASS 3. Elevations in RASS 3 range from approximately 27 feet above msl in the southeastern area to approximately 5 feet above msl in the northwestern area. The upland area has patchy vegetative cover, consisting of nonnative grasses and shrubs

RASS 4 is primarily an upland area, with a small palustrine, robust emergent marsh in the eastern portion of the site (O'Neil 1988). The nontidal wetland area of RASS 4, delineated by the USACE in 1991, is roughly defined as the area encompassing the easternmost portion of the RASS, directly north of Port Chicago Highway. The elevation of RASS 4 ranges from approximately 3 feet above msl in the eastern wetland area to a mean of approximately 20 feet above msl in the western upland area. The upland area has patchy vegetative cover, consisting of grass and bushes. Heavy rains may cause several inches of water to pond at the eastern portion of the site.

2.2.1 Geology and Soils

The geology at the Litigation Area is dominated by Pleistocene and Holocene geomorphology. The subsurface zone consists of interfingering alluvial and estuarine depositional environments. Footslopes, flood plains, and marsh or wetland areas of Quaternary age characterize the Litigation Area. Terraced Pleistocene alluvial fans and flood plain deposits form the footslopes. Pleistocene deposits are overlain by Holocene flood plain deposits that consist of unconsolidated sands, silts, gravels, and clays. In the wetland areas adjacent to Suisun Bay, Holocene alluvial material has been overlain by fine-grained silt and clay, mixed with organic material that comprises Bay Mud.

The U.S. Department of Agriculture Soil Conservation Service (SCS) identified the soil found on and around Naval Weapons Station SBD Concord. The preremediation wetland soil is Joice Muck series. The National Cooperative Soil Survey classifies wetland soil as clastic, euic, thermic Terric Medisaprists. Upland soil (on terrace deposits of alluvium) is classified as Antioch loam (fine, montmorillonite, thermic Typic natrixeralfs) or Capay clay (fine, montmorillonite, thermic Typic chromoxererts).

Wetland and upland areas at Naval Weapons Station SBD Concord are formed from sediment of three different ages and modes of deposition. At the mouths of canyons and footslopes are terrace remnants of Pleistocene alluvial fans and flood plain deposits that consist of irregularly interstratified sand, gravel, silt, and clay. The Pleistocene deposits are overlain by Holocene flood plain deposits that consist of irregularly interstratified sand, silt, gravel, and clay. The units are overlain at the margin of Suisun Bay by Quaternary Bay Mud.

Bay Muds are further defined as younger Bay Mud and older Bay Mud. The lithology of Quaternary older Bay Mud includes stiff, gray silty clay, sand, and gravel. Younger Bay Mud is a dark gray to dark brown organic clay that contains a minor amount of peat and clayey sand. Younger Bay Mud is an estuarine and marine silty clay, commonly ranging from normally consolidated to underconsolidated and soft to weak that varies in thickness from 15 to 50 feet.

Most surface areas of RASS 1 and a portion of RASS 2 are primarily underlain by younger Bay Mud and silty peat, a highly compressible fibrous soil that contains 30 to 75 percent organic materials. Both Bay Mud and silty peat are typical for bay margin marshes.

Geotechnical investigations conducted during remedial design indicated that the upper 1.5 feet of surface soil in RASS 1 typically consists of Bay Mud. Surficial clayey silt is soft to very soft and moist and contains small roots of living marsh plants. A very compressible, saturated porous peat or silty peat (a buried layer of water-saturated, spongy dead marsh vegetation) is found directly beneath the surface soil and extends to a depth of at least 3 feet.

The wetland area in RASS 2 is primarily underlain by 1.5 to 2.5 feet of dark gray, soft to medium stiff, damp to moist, plastic clayey silt. Small lenses of sand and grass roots are found in the organic clayey silt. Interbedded silty peat and silty clay units commonly occur about 2.5 feet below the surface of the wetland area. The layers of peat consist of highly compressible, saturated, spongy, very soft silty organic material of low-to-medium strength. The silty clay soil is primarily soft to stiff. The upland area in RASS 2 contains moist, loose silty sands and silts at the surface, which are underlain by gray to dark gray, wet to saturated, mostly stiff clayey silts and organic clayey silts to at least 4 feet below the surface.

The upper six inches of soil in the northwestern portion of RASS 3 is a soft to medium stiff, wet to saturated clayey silt. Surface soil in the upland area of RASS 3 is dry and very hard in the dry season.

Soil in the upland area of RASS 4 is dry and hard in the dry season and moist and stiff during the wet season. Soil in the eastern portion of the site near the wetland area consists of gray to brown, loose to firm, moist to wet, sandy silty clay.

2.2.2 Hydrology

The Litigation Area, which lies on the southern margin of Suisun Bay, includes more than 200 acres of tidal marsh. Nichols Creek drains a local watershed in the Los Medanos Hills south of the site and discharges into the marsh in RASS 1. The hydrology of the marsh is characterized by the complex interplay of tides, currents, surface water runoff, evapotranspiration, and weather. The following subsections describe the hydrologic features of the site. The role of surface water and groundwater in the migration of contaminants is discussed further in Appendix E and Section 6.4.

2.2.2.1 Surface Water

Surface water bodies in the Litigation Area consist of the natural slough in RASS 1 (referred to as Lost Slough) and tributaries that meander throughout the marsh, the network of manmade mosquito abatement ditches, a ponded area at the western end of RASS 3, the seasonal stream (Nichols Creek) that flows across RASS 3 and drains into the RASS 3 pond, and a small wetland in RASS 4.

RASS 1 is brackish marsh transected by a natural slough, tributaries, and an extensive network of mosquito abatement ditches. Semidiurnal tides in Suisun Bay cause the slough and mosquito abatement ditches in the Litigation Area to flood and drain twice daily. The ditches and slough are normally partially filled with water. Both seaward and landward currents in the ditches and slough are strong, with intervening periods of slack water. Field observations have shown that the marsh surface periodically floods during high tides and up to 2 feet of water may occur on the marsh when high tides coincide with storm events.

A network of mosquito abatement ditches that transect the surface of the RASS 1 marsh was installed in several phases between 1952 and 1969 by the Contra Costa County Mosquito and Vector Abatement District (CCCMVAD). The ditches were reworked between 1974 and 1976. No additional modifications of the ditches have occurred since 1976. Conversations with Karl Malamud-Roam of CCCMVAD indicated that the ditches were originally installed using earth-moving equipment and were a constant depth of 2 to 3 feet below grade, with the base of the ditch approximately parallel to the ground surface. Since ground surface elevation varies across the marsh, the original bottom elevation of the ditches also varied due to the constant depth of excavation. As a result of erosion and deposition (discussed in Appendix E), the ditches currently range from 1 to 5 feet deep and from 1 to 4 feet wide. The ditches are wide and deep at the proximal end (nearest the slough), but narrow and shallow at the distal end (farthest from the slough), suggesting that the distal ends of the ditches are filling. The morphology of the mosquito abatement ditches suggests that the ditches are dynamic features that are not stable over time but have changed since they were dug. Sediment is being deposited in the distal ends of ditches and eroded at the junctions of the ditches with the main slough. If that trend continues over many years, the network of mosquito abatement ditches will contract toward the slough at the center of the marsh. The changing morphology of the ditches suggests that areas of accumulation and areas of erosion of sediment occur in the ditches.

The surface of the marsh has very low relief, except for a few mounds at the western margin of the marsh, which are presumably spoils piles from excavation of the artificial channel found at the western side of

the Litigation Area; a wide elevated berm at the southeastern and eastern margin of the marsh was created by the adjacent industrial facility after the historic spills. The vast majority of the marsh surface has an elevation between 2.8 and 3.2 feet above msl (Figure 4). A broad low area (2.8 to 3.0 feet above msl) is immediately west of the remediated area in RASS 1 and north of the remediated area in RASS 2; the low area is inundated by tides more frequently than other areas.

The results of the tidal monitoring indicate that water levels in the marsh at high tides are generally 0.5 to 1 foot lower than water levels at Port Chicago, indicating that some attenuation of the high tide elevation occurs across the marsh. Water levels in the marsh at low tide were significantly higher than the levels at Port Chicago during most of February 1998, indicating that the marsh does not drain effectively during stormy periods. In contrast, during the period from February 18 through 21, water levels in the marsh closely matched low tides at Port Chicago, despite similar rainfall patterns. Patterns of marsh drainage suggest that the magnitude of the high tide exerts a controlling influence on the degree to which the marsh drains at low tide. The geometric configuration of the drainage channels apparently allows only a fixed volume of water to drain from the marsh at low tide. If an extreme high tide inundates the tidal marsh with an unusually large volume of water, the marsh does not drain completely at low tide. Most of the marsh surface lies between 2.8 and 3.2 feet above msl and is inundated by high tides from 10 to 27 percent of the time. On average, more than half of the marsh was flooded for several hours each day during the 1997 to 1998 rainy season. Because conditions were unusually wet during that period, several hours of inundation per day is most likely an upperbound of typical wet season conditions.

The dynamic shoreline at the bayward edge of the wetlands has undergone both erosion and recent deposition. Weathered boards and other debris are exposed in the eroding bank at the margin of the wetlands. Wind-generated waves play an important role in erosion of the shoreline.

In addition to shoreline erosion and deposition, three other long-term hydrologic events influence the site. First, the sea level is rising at a rate of about 1.2 millimeters per year and is expected to continue rising as a result of global warming (Stevenson and others 1986). The high tide of December 1983 was the highest ever recorded and is now the basis for the estimate of the 100-year high tide. Second, hydraulic mining in the Sierra Nevada during the last century substantially increased sediment input to the Bay Delta system, resulting in extensive shoaling and filling of intertidal areas that probably resulted in accretion of marsh, especially along the shoreline. Third, grazing in upland areas adjacent to Naval Weapons Station SBD Concord has likely increased the sediment yield of streams that discharge into the wetlands.

Nichols Creek is a narrow, seasonal creek that drains a small, undeveloped upland watershed of approximately 1 square mile in the Los Medanos Hills south of the site (Cullinane and others 1988). The creek currently runs along the western property line of the CPC, through a culvert beneath the Sacramento Northern Railroad (SNR) and Atchison, Topeka, and Santa Fe (ATSF) Railway Company railroad tracks, along the southern side of the SPTC railroad tracks in RASS 3 to the pond (Figure 3). The creek flows beneath the railroad trestle at the northwestern corner of RASS 3, thereby discharging from the RASS 3 pond to the RASS 1 marsh. The creek is narrow (3 to 5 feet wide) and shallow (1 to 2 feet deep), and the creek bed is completely dry during the dry season (typically April through October). The RASS 3 pond is hydraulically connected to RASS 1, since both sites are tidally influenced. The base of the RASS 3 pond is elevated relative to the slough and ditches, and a submerged embankment prevents complete drainage of the pond. The RASS 3 pond was created during remediation (Section 4.2.3). A dense stand of cattails (*Typha latifolia*) has been filling in the pond since the remediation was completed.

A small freshwater marsh exists in RASS 4 that is not tidally influenced or connected to the bay. The marsh receives storm water runoff from drainage canals along Port Chicago Highway and intersecting residential streets.

2.2.2.2 Groundwater

Moderate amounts of groundwater occur beneath Naval Weapons Station SBD Concord in the unconsolidated formations and bedrock. Few water supply wells are present in the area, and satisfactory yields can generally be obtained only by drilling deeper bedrock wells. Groundwater quality is generally fair; however, total dissolved solids (TDS), hardness, chlorides, and concentrations of iron are relatively high, especially when groundwater is compared with available surface water in the area. Groundwater is not a potential drinking water source since TDS in groundwater is relatively high throughout most of the Litigation Area (Appendix E).

Several wells within 1 mile of the site are used to supply water for industrial processes and cooling water for local industries. The wells are 62 to 315 feet deep and withdraw groundwater from bedrock aquifers and deep sand units within unconsolidated sediment (Environmental Solutions, Inc. 1987). Unconsolidated sediment ranges up to 150 feet thick near the Litigation Area. Two wells in the Los Medanos Hills about 0.5 mile south of the Litigation Area (Sherril wells 1 and 2) are probably used for domestic water supply. The wells are far upgradient of the Litigation Area and are 240 to 315 feet deep, so they are unlikely to be affected by Litigation Area groundwater.

The closest known drinking water supply wells surround the Mallard Reservoir, more than 3 miles southwest of the Litigation Area. The Contra Costa County Water District does not currently use the Mallard Reservoir wells for drinking water supply; however, the wells are maintained to augment the normal aqueduct supplies of drinking water during droughts.

Groundwater at the Litigation Area occurs in a shallow unconfined water-bearing zone that is predominantly composed of silty clays. Water occurs at elevations of approximately 3 to 5 feet above msl over most of the Litigation Area. Because of changes in surface elevations, depth to water ranges from about 5 feet below grade in the tidal marsh area to 45 feet below grade in the extreme southern part of the Litigation Area. Near the tidal marsh, groundwater generally flows to the northwest; however, a persistent groundwater mound in the area where Nichols Road crosses the railroad tracks causes groundwater to flow to the west and southwest in the southern portion of the Litigation Area. Groundwater flow in RASS 4 is highly variable and has been directed toward the northeast, south, southeast, and west at various times, with no apparent seasonal cause of changes in flow direction.

A tidal influence study conducted in 1997 (PRC 1997b) showed that groundwater in some portions of the Litigation Area is tidally influenced, but that groundwater and surface water do not interact to a significant extent. Groundwater and surface water may interact to a greater extent near the RASS 3 pond. Groundwater Technology, Inc. (1995) reported that groundwater at the GCC property, east of RASS 2, is tidally influenced, and water levels at that location vary by as much as 2 feet over the tidal cycle.

The majority of metals contamination in surface water is associated with suspended particles. Because suspended particles do not penetrate into the soil matrix and interaction between groundwater and surface water is very limited, surface water contamination is not expected to affect groundwater. Because groundwater flow rates in the Litigation Area marsh are extremely slow (on the order of a few feet per year), groundwater discharge to Suisun Bay is not considered significant, as further discussed in Appendix E.

2.2.3 Climate

Contra Costa County normally experiences dry, warm summers and moderately rainy winters. High-pressure ridges over the interior of California influence late spring and summer weather, resulting in higher temperatures. Prevailing cool winds, with a maritime influence, blow from the west through the wind gap formed by Carquinez Strait. As a result, the Pacific Ocean and Suisun Bay have a significant effect on the area's microclimate. Monitoring data on wind direction and speed from the Pacific Gas and Electric power plant in Pittsburg (a few miles east of the Litigation Area) indicate that winds are from the

west about 65 percent of the time, typically ranging from southwest to west-northwest at a mean speed of 12 miles per hour.

Regional rainfall may vary from 13 inches in the eastern portion of Contra Costa County to more than 30 inches on the upper slopes of Mt. Diablo. The table below summarizes the area's annual rainfall.

Total Rainfall (Inches) at the Martinez Water Plant, California													
Year	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Annual**
1990	3.2	3.4	1.4	0.3	1.8	0.0	0.0	0.0	0.2	0.2	0.3	1.4	12.0
1991	0.4	3.2	6.8	0.4	0.1	0.4	0.0	0.1	0.0	2.0	0.7	2.0	16.0
1992	1.7	6.4	2.8	0.2	0.0	0.2	0.0	0.0	0.0	1.1	0.1	6.3	18.9
1993	9.7	4.2	1.9	0.6	0.6	0.4	0.0	0.0	0.0	0.3	2.5	2.3	22.4
1994	2.0	3.8	0.3	0.9	1.5	0.1	0.0	0.0	0.0	0.8	6.9	2.4	18.5
1995	10.4	0.1	10.0	0.8	1.1	1.4	0.0	0.0	0.0	0.0	0.0	5.9	29.7
1996	5.6	5.9	2.2	1.4	1.8	0.0	0.0	0.0	0.0	0.7	2.2	6.8	26.6
1997	8.1	0.2	0.3	0.1	0.4	0.2	0.0	0.7	0.1	0.8	6.3	2.5	19.6
1998	7.2	12.2	2.0	1.3	2.7	0.0	0.0	0.0	0.1	0.4	2.4	1.6	29.9
1999	2.7	5.3	1.9	1.9	0.1	0.0	0.0	0.0	0.0	0.4	1.4	0.4	14.2
2000	6.6	7.8	1.9	0.9	1.1	0.1	0.0	0.0	0.1	1.7	1.0	0.8	21.9
2001	2.8	7.2	1.1	1.1	0.0	0.2	0.0	0.0	0.2	0.3	3.8	7.0	23.7

Note: Shading indicates El Nino was in effect.

Source: Western Regional Climate Center. 2002. "San Francisco Bay Area, California Climate Summaries." March 12. Online Address: http://www.wrcc.dri.edu/summary/climsmsfo.html

The Navy primarily conducted chemical sampling during the postremediation monitoring program in the dry season except during the year 2 monitoring event. Monitoring was conducted for year 1 through 5 during the following sampling periods:

- Year 1: August to September 1995
- Year 2: December 1996 to March 1997
- Year 3: May to June 1997
- Year 4: June to July 1998
- Year 5: May to June 1999

To further characterize the potential effect of rainfall patterns on contaminant and sediment migration, the Navy characterized wet season streamflow in Nichols Creek in March 1998 and conducted storm event sampling in the RASS 1 sloughs and ditches during the wet season from January to April 1999. In

addition, the Navy sampled incoming and outgoing tides during the wet and dry seasons for water quality (Appendix E) and sampled groundwater during all four seasons. Groundwater sampling indicated no seasonal patterns existed.

2.3 ECOLOGICAL CHARACTERISTICS

Suisun Bay is a transition zone between the marine influence of San Francisco Bay and the freshwater influence of the Sacramento and San Joaquin Rivers. The lower wetland portion of the Litigation Area, particularly in RASSs 1 and 2, is a dynamic marsh habitat characterized by vegetation that tolerates frequent inundation by brackish water. This wetland habitat is characterized by high plant diversity and the presence of populations of special status species. Some special status species observed at the Litigation Area include the salt marsh harvest mouse (*Reithrodontomys raviventris*) (federally and state-listed endangered species), the California Black Rail (*Laterallus jamaicensis coturniculus*) (state-listed threatened species), and soft bird's beak (*Cordylanthus mollis mollis*).

The drier upland portions of the Litigation Area, particularly RASSs 3 and 4, are predominantly disturbed grasslands with nonnative grasses and some shrubs such as the native coyote brush. The small marsh at the western end of RASS 3 is tidally influenced and has been colonized by plant and animal species characteristic of both freshwater and brackish marshes. A small freshwater marsh is found on the eastern edge of RASS 4 and is dominated by cattails. A more complete description of habitats and species is presented in the BERA (Appendix G).

3.0 SITE CHRONOLOGY AND BACKGROUND

The Litigation Area was purchased by the Navy to create a buffer zone around its munitions loading operations; the Navy has not conducted operations on this property that contributed contamination. The Navy acquired parcels of land from the Santa Fe Railroad Foundation, Inc.; the Allied Chemical Corporation; the Getty Oil Company; and from other property owners in 1969 and 1970. A chronology of major events at the site, including changes in land use and historic contamination spills, historic sources of contamination, and brief summaries of early investigations, is provided in the following sections. This information was based in part on a review of historical topographic maps, aerial photographs, and available site documents (Appendix A).

The site history and changes in land use are described in Section 3.1. The historic sources of contamination in the Litigation Area are summarized in Section 3.2. Previous investigations and legal documentation are described in Sections 3.3 through 3.6. Section 3.7 presents the National Priorities List (NPL) status of Naval Weapons Station SBD Concord. Appendix A includes a list of site-related documents that were reviewed. The site chronology of major events in contaminant investigation and remediation at the Litigation Area is provided in Table 1.

3.1 SITE HISTORY

Changes in land use and natural features in the area around the Litigation Area were researched by reviewing topographic maps from 1866 and 1884 and aerial photographs from 1952 to present. Earlier aerial photographs did not contain sufficient detail or resolution to interpret site history. Notable site features were identified in aerial photographs from 1952, 1969, 1976, 1988, and 1996, including buildings and areas of stressed vegetation or barren zones.

The topographic survey map from 1886 showed that the Litigation Area was completely undeveloped, except for railroad tracks, and that the location and course of Lost Slough in 1886 was essentially the same as it is today.

The Nichols Chemical Plant began operation in the area just east of the Litigation Area in 1905. This large industrial facility has included numerous operating companies, many of which have changed their names. The Nichols Chemical Company merged to form Allied Chemical Corporation, which changed its name to Allied Signal, Inc. Allied Signal, Inc. sold part of the land to GCC in 1985. In addition, the current property owner of the waste lagoons adjacent to RASS 1 is Honeywell, Inc. For the purpose of this report, the entire facility will be referred to as Allied Signal/General Chemical facility, and individual

companies will be identified as appropriate. A complete review and site history of this facility is provided in Appendix E.

Industrial development of the area was well underway by 1952. An aerial photograph shows that the Allied Signal/General Chemical facility and waste lagoon and a Getty Oil pumping facility were operating in 1952 (Figure 5), and that a residential housing area was present southeast of the Getty Oil pumping facility. The Getty Oil pumping facility was developed around 1930 and was used until the Navy purchased the property in 1971 (PRC and William Self and Associates [WSA] 1992). The Getty Oil facility consisted of two aboveground tanks, six small buildings, and a manmade surface impoundment.

The CPC manufacturing facility was established between 1959 and 1963 adjacent to Nichols Creek. Between 1963 and 1966, 10 small mound-shaped kilns were installed by Allied Chemical Corporation in the area north of Getty Oil, currently known as RASS 2.

Historic aerial photographs reveal that the Litigation Area marsh and the Nichols Creek area had suffered multiple episodes of spillage from the chemical treatment lagoon at the Allied Signal/General Chemical facility to the east and from discharges from the CPC into Nichols Creek on the southeastern border of RASS 3. As early as 1952 (Figure 5), an area of stained soil along the eastern boundary of the Navy's property indicates that spillage occurred from the chemical treatment lagoon. The affected area was considerably larger in 1957, suggesting additional spillage or spread of the original spill. Two other major spill episodes occurred between 1963 and 1969 (Figure 6) and between 1974 and 1976 (Figure 7). Both of those spill episodes resulted in stained soils and stressed vegetation or defoliation as much as 2,000 feet west of the chemical treatment lagoon. An aerial photograph from 1976 (Figure 7) shows visible evidence of tillage of contaminated soils in RASS 1, providing clear evidence of some sort of treatment. Soils in the rest of the spill area were not tilled. The area where tilling was observed in the aerial photograph is in the furthest eastern portion of RASS 1, adjacent to the eastern boundary of the property. The RI and FS (Lee and others 1988a; Cullinane and others 1988) also indicate that lime was added to the soil in this area in 1976 to reduce pH.

The extensive network of mosquito ditches is a prominent feature of the Litigation Area marsh that has a profound effect on site hydrology. Review of photographs revealed that ditches were installed in several stages beginning between 1952 and 1957 (Figure 5). The first ditches were installed in the central portion of the Litigation Area marsh. The second phase of ditch installation occurred between 1957 and 1959, when ditches in the northern half of the marsh were installed. The third major phase of ditch installation

occurred between 1966 and 1969 (Figure 6), when ditches in the southwestern portion of the marsh were installed. The southeastern network of ditches was reworked between 1974 and 1976 (Figure 7), and intermediate ditches were installed between existing major ditches. From 1976 to present, the network of ditches does not appear to have been modified (Figures 7 through 9).

By 1969, two additional unknown commercial/industrial operations were established east and west of the CPC facility, and the nearby residential area was razed (Figure 6). A major disturbed area was identified in a 1969 photograph in the area now occupied by the RASS 3 pond. Between 1971 and 1974, the Getty Oil facility was razed and the kilns were removed. By 1976, an impoundment was created in the western portion of the CPC facility, and the western commercial/industrial facility was razed. From 1988 to 1996 (Figures 8 and 9), major site features remained essentially unchanged, except for the addition of a tarp-covered soil pile to the south of the CPC facility (the tarp covers contaminated soil removed during site remediation at CPC) and the addition of the GWF power plant to the east of the facility. Limited areas of stressed vegetation or exposed soil were visible in the 1996 aerial photograph near the CPC and in the remediated areas of RASS 2 and 3 (Figure 9).

The course of Nichols Creek, which traverses RASS 3 and empties into the tidal marsh, has changed in recent times. The creek used to run under the railroad track through a culvert onto the Kiln Site in RASS 2, where it would often puddle. When the culvert became plugged, the stream flowed to a new outlet under the railroad trestle on the western side of RASS 3, where it still flows today. It is not clear exactly when this change occurred.

3.1.1 Remedial Action Subsite 1

RASS 1 covers approximately 210 acres adjacent to Suisun Bay and is comprised of tidally influenced brackish wetland, with minimal upland and associated transitional zone habitat. The Navy did not conduct any operations on the site that contributed contamination. The major sources of contamination to RASS 1 were historic spills from (1) the adjacent Allied Signal/General Chemical facility to the east, (2) the Allied-Signal property adjacent to the southeastern corner of the RASS 1 wetland, and (3) the CPC facility upstream on Nichols Creek (historic spills and dumped contaminants were carried downstream to the slough in RASS 1). Thus, the major sources of contamination to RASS 1 were all off-site adjacent properties.

A 1908 U.S. Geological Survey (USGS) quadrangle map shows an apparent walkway from the General Chemical structure across the marsh area in RASS 1 to Middle Point, where a navigational beacon appears to have been in operation. Review of historic aerial photographs shows numerous large spills

originating from the Allied Signal/General Chemical facility to the east. In addition, as described above, the original course of Nichols Creek emptied into the RASS 2 area and likely contributed to contamination of RASS 1 and RASS 2 from the upstream CPC. The course of Nichols Creek has changed and it now empties under the railroad trestle further west and flows into a mosquito ditch that empties into Lost Slough; this more recent course likely carried zinc contamination from the original source to the slough in RASS 1.

In 1976, the California Department of Fish and Game (CDFG) sampled marsh water near RASS 1. The samples indicated that the water was contaminated because of low pH runoff (as low as 1.2), possibly from Allied Chemical Corporation's hydrofluoric acid-recycle system ponds and the alum mud and iron oxide that covered most of the northern portion of the chemical plant property. In 1977, Allied Chemical Corporation scraped approximately 7,800 cubic yards of contaminated soils from the north side of the RASS 1 active remediation area and applied agricultural lime to 8 acres on the south side of the RASS 1 active remediation area (Ecology and Environment [E&E] 1983).

3.1.2 Remedial Action Subsite 2

RASS 2 consists of approximately 13 acres of upland, wetland, and transitional habitat and lies directly south of RASS 1. The Navy purchased the RASS 2 property in 1969. The Navy did not conduct any operations on the site that contributed contamination. The major sources of contamination to RASS 2 were from (1) some on-site brick kilns operated by the former property owner (Allied Chemical Corporation), (2) historic spills from the off-site and adjacent Allied Signal/General Chemical Company, and (3) dumping and historic spills carried from the off-site CPC through Nichols Creek to RASS 2.

A series of brick kilns, or Herschoff Ovens, was constructed in RASS 2 around 1963, and the kilns were used until 1974 by Allied Chemical Corporation (Lee and others 1986). Aerial photographs of the area in 1971 show 10 kilns on the site, each about 10 feet in diameter (PRC and WSA 1992). After the kilns were demolished in 1974, the debris was spread over the ATSF rights-of-way and over RASS 2 (Martin Marietta Energy Systems, Inc. 1993). In 1982, Naval Weapons Station SBD Concord (then Naval Weapons Station Concord) contracted the development of a cleanup plan for the area (E&E 1983); some soil and debris were removed at that time. When the cultural resources survey was performed in 1991, all that remained of the kilns was a mound of kiln-brick rubble that was subsequently removed under the remedial action (PRC and WSA 1992). The original course of Nichols Creek passed through a culvert under the railroad track and emptied into the marsh at the Kiln Site, contributing contamination from upstream sources at the CPC. Although occupying a slightly higher elevation than RASS 1, RASS 2 was

also likely to be contaminated by historic spills from the Allied Signal/General Chemical facility to the east.

3.1.3 Remedial Action Subsite 3

RASS 3 consists of approximately 71 acres of upland and lies south of RASSs 1 and 2. The Navy did not conduct any operations on the site that contributed contamination. The major source of contamination to RASS 3 was from the historic dumping and spills from the off-site CPC facility that is upgradient from RASS 3 and adjacent to Nichols Creek. The historic and current flow pathway of the creek spread contamination throughout the drainage area in RASS 3. In addition, the on-site Getty Oil pumping facility may have contributed petroleum and metals to the site.

The 1908 USGS quadrangle map shows an unidentified structure directly south of the current CPC facility, along Nichols Road. No remains of the structure can be found at the site. The former Nichols School, which was constructed in 1913 and razed in 1949, was in RASS 3, directly north of Port Chicago Highway (PRC and WSA 1992).

From approximately 1930 to 1970, a large northern portion of RASS 3 was the site of the Getty Oil Nichols Pump Station. After the Navy purchased the land in 1976, all structures associated with the pumping station were razed. An aerial photograph taken in 1959 shows a very large facility in the middle of RASS 3, two aboveground tanks (with lines connecting the tanks to the building), six smaller buildings along the ATSF tracks, a manmade surface impoundment, and numerous additional structures and trees. A dirt parking lot was also present, directly south of the CPC facility.

3.1.4 Remedial Action Subsite 4

RASS 4 consists of approximately 13 acres of upland and nontidal wetland areas almost 1.5 miles east of RASSs 1, 2, and 3. The Navy did not conduct operations on the site that contributed any contamination. The major sources of contamination to RASS 4 were from coke piles that were historically stored in this area and a dump operated by the former landowners on the site. An adjacent off-site fertilizer plant may also have contributed some contamination.

Joe and Wilda Sobotka owned and operated a dumpsite at RASS 4 until the Navy acquired the property in 1968 (PRC and WSA 1992). RASS 4 was historically used for storing coke, and the original site name was the Coke Pile site. The recently discovered site, area of concern 1 (AOC1), which is west of RASS 4 and includes a fertilizer plant, may have contributed contamination to this site. A pile of construction

debris (concrete and rubble) was formerly located in the wetland area of RASS 4; the debris was removed in 1993 under the remedial action.

3.2 HISTORIC SOURCES OF CONTAMINATION

The Navy did not conduct any operations on the RASSs that contributed contamination; the Navy has used these properties only as buffer zones. The neighboring chemical companies were the primary sources of most of the contamination at the Litigation Area (Figure 3). Smaller on-site sources from previous landowners may have contributed some contamination to RASSs 2, 3, and 4. While most of this contamination was released in the past 50 years, ongoing sources of contamination may still exist off site. The potential for continued contamination of Navy property is further discussed in Section 6.4 and Appendix E.

3.2.1 Allied Signal/General Chemical Facility

The off-site Allied Signal/General Chemical facility, adjacent to RASS 1, has been industrially active since 1905. Several different companies, involving a variety of manufacturing processes and chemical products, have occupied this site (Appendix E). This facility produced, or produces, aluminum sulfate, sulfuric acid, hydrofluoric acid, nitric acid, acetic acid, and many other chemical products. Early Navy investigations identified areas of the facility that were potential sources of contamination, including (Cullinane and others 1988):

- **Old Alum Pond:** An area used until 1973 for the disposal of alum mud generated in the manufacture of aluminum sulfate.
- **Lined Alum Ponds:** Lined alum ponds currently used to dispose of alum mud.
- **Wastewater Treatment Lagoon:** A wastewater treatment and recirculation lagoon with high concentrations of aluminum, arsenic, cadmium, zinc, fluoride, and formaldehyde regulated under the National Pollutant Discharge Elimination System permit.
- **Iron Pyrite Cinder and Coke Disposal Area:** A large area east of the old alum pond and west of the treatment lagoon used for the disposal of iron pyrite cinders generated during the manufacture of sulfuric acid from iron pyrite ore and the disposal of coke used in this process; waste material was buried to depths of 10 feet.

GCC is conducting an ecological risk assessment (ERA) and a HHRA. A chronology of site investigations at this facility is provided in Appendix E, as well as an assessment of whether this facility still acts as an ongoing source to the Litigation Area.

3.2.2 Chemical and Pigment Company

The off-site CPC (ESI Chemical Company is also cited in early documents as occupying this site) lies adjacent to Nichols Creek and southeast of RASS 3. This company produced zinc chloride from galvanized waste and manufactured zinc- and copper-based chemicals. This company is no longer operating but inorganic contaminants are still present on the property at high levels in soil and groundwater. The California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) is the lead agency overseeing this site. A chronology of site investigations is provided in Appendix E, as well as an assessment of whether this facility is still an ongoing source to the Litigation Area.

3.2.3 Getty Oil Company

Getty Oil built an oil pumping facility on site in the area of RASS 3 between the railroad tracks in the 1930s. The Getty Oil Nichols Pumping Station operated until 1971, when the Navy purchased the property and removed the facility structures. In 1993, during the remediation of RASS 3, the Navy encountered an oil pipeline underground near the Getty Oil facility and an oily substance in subsurface soils. This area and the area downgradient were sampled for petroleum hydrocarbons in soil and groundwater. Total petroleum hydrocarbons (TPH) as motor oil and TPH as diesel were detected in soil, with maximum concentrations of 8,900 milligrams per kilogram (mg/kg) and 4, 200 mg/kg, respectively (PRC 1993). TPH as gasoline was detected in soil, with a maximum concentration of 2,800 mg/kg. An unidentified fuel (not motor oil or diesel) was detected in groundwater (0.2 milligram per liter) at well location 3MG12. No additional remediation was recommended for petroleum, since TPH had not affected groundwater based on sampling of monitoring wells at the site and no receptors would be exposed to subsurface contamination (PRC 1993). Little other historic information has been found about this facility; this facility is no longer in existence.

3.2.4 Other Potential Historic Sources of Contaminants

In addition to the chemical companies addressed above, a variety of other activities in or near the Litigation Area may have contributed contaminants to the site. These activities include:

- **Kilns in RASS 2:** Until 1974, up to 10 brick kilns were on site in RASS 2, 400 yards west of the Allied Signal/General Chemical facility and operated by a former property owner. The use of these kilns is not known but this area was found to be contaminated with metals and possibly coke filter materials.

- **Railroad Activities:** Three railroads, the ATSF, SPTC, and SNR bisect the Litigation Area. Off-site activities such as engine operations, track maintenance operations, spraying of herbicides along tracks, creosote-soaked railroad ties, or accidental or illegal dumping along the tracks could all have contributed to some contamination in the Litigation Area. Some of these off-site sources may be ongoing. The railroad right-of-way includes 50 feet on either side of the track; this area adjacent to the Litigation Area is known to be contaminated with metals from historic spills. The railroad companies are conducting their own investigations and some of their proposed cleanups have not been completed.

- **Coke Piles and Dumping in RASS 4:** Initial investigations identified coke piles on site in the area that became known as RASS 4. The origin of these piles is not known but they are considered to be the major historic source of contaminants in RASS 4. Joe and Wilda Sobotka owned and operated a dump on site at RASS 4 until the Navy purchased the property in 1968 (PRC and WSA 1992).

- **Area of Concern 1:** AOC1 is a recently discovered site on Navy property just west of RASS 4. A variety of inorganic chemicals found at this former fertilizer plant and waste storage area may have contributed to contamination of RASS 4. The Navy is currently conducting a time-critical removal of much of the contamination on this site.

- **Mosquito Abatement Activities:** CCMVAD has conducted mosquito abatement activities for many decades in the marshes of the Litigation Area. These activities included regular monitoring and spraying of insecticides, such as dichlorodiphenyltrichloroethane (DDT), and more recently "Golden Bear," a mosquito larval growth inhibitor. Mosquito abatement activities are ongoing.

- **Import of Contaminants from Suisun Bay and the Sacramento and San Joaquin Rivers:** Based on results of the Regional Monitoring Program, the waters and sediments of Suisun Bay and the river delta are known to be contaminated with inorganic and organic chemicals as a result of the extensive agricultural, industrial, and urban development in the Central Valley. The accreting portions of the Litigation Area marsh are expected to have imported sediments from the delta sources; the sediments may be contaminated by these off-site sources. Tidally influenced surface waters entering the site are expected to be contaminated to the same extent as Suisun Bay and may have contributed to on-site contamination levels.

3.3 EARLY INVESTIGATIONS

The Navy was informed in 1980 by the California Department of Health Services that the land purchased from the neighbors was contaminated. The Navy initiated a series of investigations that resulted in a ROD, signed by the Navy in 1989, proposing cleanup of the most contaminated portions of the Litigation Area. The following sections summarize these early investigations.

3.3.1 Initial Assessment Study

The Navy conducted an initial assessment study (IAS) of the Litigation Area from 1981 to 1983 under the Navy Assessment and Control of Installation Pollutants Program (E&E 1983). The IAS was based on interviews, archival reports, site inspections, and analysis of samples. The IAS identified six sites,

covering eight parcels in the Litigation Area, that showed evidence of metals contamination, including arsenic, cadmium, copper, lead, selenium, and zinc (E&E 1983). A subsequent study confirmed that soil in several areas contained high concentrations of metals, including arsenic and selenium (Anderson Geotechnical Consultants 1984). The six sites identified for further study are shown on Figure 10 and include:

- **Allied Site A (AA):** This site was several acres in size and was adjacent to Allied Chemical Corporation property. The suspected contamination source was Allied Chemical Corporation's hydrofluoric acid recycle system ponds and the alum mud and iron oxide that covered their property. Soils were found to be contaminated with high levels of arsenic, copper, cadmium, iron, and lead. Sampling in 1976 also found low pH (1.2) contamination in runoff. In 1977, Allied Chemical excavated 7,800 cubic yards of soil in a state-mandated cleanup of the area (Figure 10). However, in 1980 and 1981, the Navy collected additional samples showing that the area was still contaminated with arsenic (360 parts per million [ppm), copper (3,700 ppm), and zinc (10,100 ppm), as well as cadmium, iron, and lead. This site was included in RASS 1.

- **Allied Site B (AB):** This site is contiguous with site AA and was contaminated with high levels of copper, iron, and zinc. In 1976, the RWQCB detected low pH in runoff. In 1977 Allied Chemical stated that cleanup of the site would include applying agricultural lime to 8 acres and constructing a dike to limit the extent of contaminated runoff. Samples collected in 1980 showed high levels of copper (185 ppm), iron (67,800 ppm), and zinc (974 ppm). This site was included in RASS 1.

- **Kiln Site (KS):** This site comprises 5 acres 400 yards west of Allied Chemical and was found to be contaminated with metals and possibly coke filter materials. Until 1974, up to 10 brick kilns were located at the site; when the kilns were dismantled, debris was spread along the railroad embankment. Two samples collected in 1982 showed arsenic at concentrations ranging from 300 to 400 ppm and lead at concentrations up to 29,000 ppm. Selenium concentrations detected at slightly higher than background indicated the possible presence of coke filter materials. This site was included in RASS 2.

- **K-2 Area (K-2):** This site was southwest of site AB, but is separated from site AB by the Southern Pacific Railroad (Figure 10). A small stream (Nichols Creek) flows next to the CPC and ESI Chemical Company facility and traverses this site before emptying into the tidal marsh; this stream used to flow through a culvert onto the KS. The chemical companies at one time dumped waste into the stream, resulting in the contamination in this area. In 1982, the Navy collected surface soil samples that showed high concentrations of arsenic (760 ppm), copper (3,600 ppm), lead (5,200 ppm), and zinc (93,000 ppm). This site was included in RASS 3.

- **G-1 Area (G-1): –** This 6-acre site was previously owned by Getty Oil and was found to be contaminated with lead (150 ppm) and zinc (1,100 ppm) in 1982. Contamination was detected only at the bottom of an abandoned sump. This site was included in RASS 3.

- **Coke Pile Site (CP):** An estimated 1,500 cubic yards of spent coke with heavy metals and low pH was found at this site. Surficial contamination appeared to be localized. This site was included in RASS 4.

3.3.2 Remedial Investigation

The results of the IAS and confirmatory study led to the development of an RI conducted by WES that focused on the sites shown on Figure 10 (Lee and others 1986, 1988a). Surficial soils and sediments sampled during the RI at the Litigation Area contained high concentrations of arsenic, cadmium, copper, lead, selenium, and zinc. In addition, low pH values were detected in RASS 4. A limited number of sediment and water samples were analyzed for organic compounds; based on the results of those analyses, the RI concluded that organic compounds were not potential COCs. Metals identified in soil were assumed to have resulted from activities conducted on adjacent properties and operations in the Litigation Area before the Navy acquired the property.

While EPA's ERA framework had not yet been developed, the biological assessment work conducted for the RI was fairly extensive and included activities that would be required in a risk assessment, including toxicity tests, site-specific bioaccumulation measurements, and estimates of risk to higher-level receptors. Ecological and toxicological data were used to delineate areas that showed ecological effects such as increased mortality of plants and earthworms, reduced abundance of invertebrates in the soil, or increased bioaccumulation of metals of concern in organisms.

An additional site called ES was identified in RASS 3 during the RI. This area was likely contaminated by releases from the ESI Chemical Company and CPC facilities (Figure 10).

The RI identified two reference areas that were used for comparative purposes: the upland and shoreline reference areas. The upland reference area (site BK133 on Figure 10) is the same upland reference area currently in the monitoring program (Figure 2). The shoreline reference area (site BK116 on Figure 10) is east of the marsh reference area that is currently used by the monitoring program (Figure 2).

The RI recommended that remedial actions be considered for the most contaminated portions of the seven sites (AA, AB, KS, G-1, K-2, ES, and CP) investigated. Six metals (arsenic, cadmium, copper, lead, selenium, and zinc) were identified as COCs in the RI.

3.3.3 Feasibility Study

WES conducted an FS that was documented in three volumes: "Volume I: Feasibility Study" (Cullinane and others 1988), "Volume II: Biological Assessment" (O'Neil 1988), and "Volume III: Figures" (Lee and others 1988b). The FS included:

- A delineation of each RASS
- An evaluation of the extent of contamination and potential migration
- A summary of available chemical and biological data to support remedial decisions
- A summary of ARARs that could be used to generate environmental protection goals
- A summary of chemical-specific criteria and location-specific factors used to develop cleanup criteria for each RASS
- An evaluation and preference ranking for remedial alternatives
- A biological assessment.

Based on identified contamination, topography and habitat, and potential remedial alternatives the seven RI sites were delineated into four RASSs, as follows:

Remedial Action Subsite	Includes Portions of Parcels	Includes Sites Identified in RI (Lee and others 1988a)	Acres	Habitat
RASS 1	571 and 572	Allied Site A Allied Site B	209.78	Brackish marsh with sloughs and ditches
RASS 2	572	Kiln Site	13.32	Brackish marsh and transitional upland
RASS 3	573, 574, 575, 576, and 579D	K-2 Area ES Site G-1 Area	71.21	Upland, freshwater marsh, and seasonal creek
RASS 4	581	Coke Pile Site	13.29	Upland and freshwater marsh

Notes:

RASS Remedial action subsite
RI Remedial investigation

Numerous statutory ARARs were identified in the FS; the adequacy and suitability of remedial alternatives was evaluated in the context of these ARARs. WES documented the lack of regulatory criteria or standards for soil or sediment cleanup and identified other criteria, standards, or guidance that could be used to guide cleanup levels. Some of the criteria or guidance values evaluated included:

- **Absolute Relationship to Reference Values:** Evaluation of remediation of soil concentrations above those detected in the site reference areas (shoreline reference area and upland reference are shown on Figures 2 and 10 [as BK116 and BK133]).

- **Statistically Above Reference Area Criteria (SARAC):** Evaluation of statistical differences between site and reference area (shoreline reference area and upland reference area shown on Figures 2 and 10 [as BK116 and BK133]) concentrations.

- **Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC):** State of California criteria based on extraction procedures that determine whether a material is considered hazardous. These criteria were designed to protect groundwater at disposal sites and are used to evaluate disposal requirements for waste material in California.

- **Maximum Allowable Sewage Sludge Application (MASSA):** U.S. Department of Agriculture guidelines for the maximum amount of metals in sewage sludge that can be applied to croplands.

- **Low pH Criterion:** A low pH criterion of 5.5 was considered based on the concern about toxicity of cadmium, copper, iron, lead, nickel, and zinc at low pH.

- **Extractive Procedure Toxicity:** EPA promulgated this test for determining the hazardous nature of contaminated or waste material; this test is similar to STLC and was designed to evaluate disposal rather than the need for removal.

Other potential criteria or guidance such as water quality objectives and Department of Food and Agricultural standards were cited in the FS but were not discussed in the final selection of remedial action objectives.

Potential ecological effects were found to occur most frequently in areas where concentrations of metals in soil exceeded California's TTLC or STLC criteria. Although TTLC and STLC screening values were established in California to identify hazardous waste, it was concluded that these screening values were useful for estimating the extent of areas where ecological effects were present. Another set of screening values, referred to as SARAC, was also selected for use in the remedial action for RASS 3. Cleanup criteria for RASS 3 were more stringent than cleanup criteria for RASSs 1 and 2, as set forth in the FS (Cullinane and others 1988):

> "In reviewing factors impacting the selection of criteria for RASS 3, it was noted that RASS 3 was a source of contamination to RASS 1 and RASS 2. In addition, the wetlands and habitat provided by RASS 3 are believed to be relatively resilient to intrusive remedial action and are not inhabited by endangered species. Because of these factors, the short-term impacts resulting from contaminant removal are expected to be less than the anticipated short-term impacts in RASS 1 and 2. Therefore, application of the stringent 'statistically above reference' criteria appear appropriate."

Each RASS was divided into three areas on the basis of the proposed action: active remediation, passive remediation, and monitoring. Potential modifying factors specific to each RASS were also considered in determining the extent of active remediation, including potential for an area to act as a source of

contamination to other areas, precedence in cleanups at other sites, presence of wetlands, presence of endangered species, and topography.

Remedial alternatives were evaluated separately for each RASS based on technical feasibility, environmental considerations, institutional considerations, and public health considerations. Each alternative was ranked in order of preference. TTLC, STLC, and SARAC values were identified as remedial action objectives in areas to be actively remediated through excavation and off-site disposal of contaminated soil. Some contamination was left in place in passive remediation areas to minimize destruction of wetland habitat for endangered species and because of concerns about the technical feasibility of remediation. Remedial action objectives for the actively remediated portion of each RASS are listed in the following table.

	RASSs 1, 2, and 4		RASS 3		
Chemical	**TTLC[1]**	**STLC[2]**	**SARAC[3]**	**TTLC**	**STLC**
Arsenic	500.0	5.0	NA	500	5.0
Cadmium	NA	NA	12.7	NA	1.0
Copper	2,500	25.0	345	NA	25.0
Lead	1,000	5.0	NA	1,000	5.0
Selenium	NA	NA	NA	100.0	1.0
Zinc	NA	NA	2,512	NA	250.0

Notes:

1 Total threshold limit concentration expressed in milligram per kilogram (mg/kg) wet weight
2 Soluble threshold limit concentration expressed in milligram per liter
3 Statistically above reference area criteria expressed in mg/kg dry weight. (Shoreline reference area and upland reference area are shown on Figures 2 and 10 [as BK116 and BK133].)
NA Not applicable
RASS Remedial action subsite
SARAC Statistically above reference area criteria
STLC Soluble threshold limit concentration
TTLC Total threshold limit concentration

A biological opinion issued by the U.S. Fish and Wildlife Service (USFWS) on the evaluation of impacts to special status species from the proposed remedial action required that a biological assessment be conducted for the FS (O'Neill 1988). The biological assessment included vegetation sampling, small mammal trapping, and incidental wildlife observations. The salt marsh harvest mouse, California Clapper Rail (*Rallus longirostris obsoletus*), California Black Rail, and the Delta tule pea (*Lathyrus jepsonii* ssp. *jepsonii*) were confirmed to be present at the site. The biological assessment reviewed data collected during the RI on toxicity and bioaccumulation and determined that the presence of multiple metals at elevated concentrations suggested a concern for resident wildlife. The harm to the environment from

chemicals released at the site was weighed against the harm that would result from active remediation. Because of the presence of wetlands and endangered species in RASSs 1 and 2, the extent of remediation was recommended to be limited to minimize disturbance of critical habitat. The following subsections outline the conclusions of the FS for each RASS.

3.3.3.1 RASS 1

The following recommendations were made for RASS 1:

- **Active Remediation (9.03 acres):** Active remediation of areas that exceed TTLCs and STLCs. This area was reduced to the easternmost portion of RASS 1 to account for topography and presence of wetland and endangered species, leaving 7 acres with known concentrations above TTLCs and STLCs. The active area was increased to include some barren areas not contained within the TTLC and STLC boundary. The highest ranked remedial alternative was excavation, immobilization, and disposal of contaminated soil in an existing Class III landfill and restoration.

- **Passive Remediation (23.01 acres):** Passive remediation and extensive monitoring, with the potential for further active remediation, in areas of contamination not actively remediated.

- **Monitoring (177.74 acres):** Monitoring, less intensively than in passive remediation zone, in the remainder of RASS 1.

3.3.3.2 RASS 2

The following recommendations were made for RASS 2:

- **Active Remediation (4.17 acres):** Active remediation of areas that exceed TTLCs and STLCs; the active area was increased to include barren areas not contained within the boundaries of concentrations exceeding TTLC and STLC. The highest ranked remedial alternative was excavation, immobilization, and disposal in an existing Class III landfill and restoration.

- **Passive Remediation (0.94 acres):** Passive remediation and extensive monitoring, with the potential for further active remediation, in areas of contamination not actively remediated.

- **Monitoring (8.21 acres):** Monitoring, less intensively than in passive remediation zone, in the remainder of RASS 2.

3.3.3.3 RASS 3

The following recommendations were made for RASS 3:

- **Active Remediation (4.66 acres):** Active remediation of areas that exceed TTLCs and STLCs or SARACs. The actively remediated area was increased to include a small area with elevated metals concentrations near the Nichols Creek railroad trestle. The highest ranked remedial alternative was excavation, immobilization, and disposal in an existing Class III landfill and revegetation.

- **Passive Remediation (1.01 acres):** Passive remediation and extensive monitoring, with the potential for further active remediation, in areas of contamination not actively remediated.

- **Monitoring (65.54 acres):** Monitoring, less intensively than in passive remediation zone, in the remainder of RASS 3.

3.3.3.4 RASS 4

The following recommendations were made for RASS 4:

- **Active Remediation (0.87 acre):** Active remediation of areas that exceed TTLCs and STLCs or the low pH criterion of 5.5. The highest ranked remedial alternative was excavation, immobilization, and disposal in an existing Class III landfill.

- **Passive Remediation (0.54 acre):** Passive remediation and extensive monitoring, with the potential for further active remediation, in areas of contamination not actively remediated.

- **Monitoring (11.88 acres):** Monitoring, less intensively than in passive remediation zone, in the remainder of RASS 4.

3.4 RECORD OF DECISION AND REMEDIAL ACTION PLAN

A ROD for the Litigation Areas was signed by the Navy on April 6, 1989, and issued by the Department of Defense on October 4, 1989. The ROD included a final RAP that was completed on September 16, 1988. The ROD and the RAP were prepared in accordance with the 1985 National Contingency Plan. The RAP contained the following general environmental goal:

> Prevent or minimize the release of hazardous substances causing substantial danger to present or future human health or the environment, using cost-effective measures, without adversely affecting important wildlife habitat in the long term.

In addition, the Navy had established four primary remedial objectives for remedial action in the FS:

1. Prevent biota from contacting contaminated soils that would threaten them
2. Prevent resuspension in surface water and air and redistribution of the contaminated sediments and soils that would threaten the flora and fauna

3. Minimize disturbance to the wetland consistent with long-term protection of flora and fauna

4. Prevent migration of contaminants into groundwater

The Navy relied on available ARARs and other guidance to specify the level of cleanup required to meet CERCLA's objective of protecting human health and the environment. Location-, chemical-, and action-specific ARARs for each RASS were listed in the RAP. The Navy selected TTLC and STLC criteria established under California's approved Resource Conservation and Recovery Act (RCRA) program as the implementable standards for conducting active remediation.

As described in Section 3.3.3, the Navy identified the areas for active remediation (excavation), passive remediation, and monitoring in each RASS. The Navy determined that full remediation to TTLC and STLC criteria in RASSs 1 and 2 would result in greater risk to the environment than alternative options. As a result, the Navy waived compliance with these requirements for approximately 8.21 acres, as provided in CERCLA Section 121(d)(4). The Navy published these findings in the ROD and RAP, as required by CERCLA.

The preferred remedial alternative in the FS to meet the decision rules proposed immobilizing contaminants as well as excavation, disposal, and restoration. However, treatability tests determined that reagents applied to contaminated soils could not sufficiently immobilize arsenic to meet STLC criteria. As a result, in the RAP, the Navy identified the second preferred alternative that included excavation, disposal, and restoration to meet decision rules.

The ROD concluded that the selected remedial response would be protective of human health and the environment and that none of the alternative remedial actions could practicably and permanently reduce the volume, toxicity, or mobility of hazardous substances. The Navy found that the selected alternative attained the standards or level of control identified by ARARs, except for the 8.21 acres where compliance was waived to prevent greater risk to the environment.

In the ROD, the Navy stated that the remedial alternatives should also be implemented on off-site parcels owned by the railroads to prevent recontamination of the Navy's property. In consent decrees between the United States and the railroads (Section 3.6), the railroads agreed to implement the appropriate remedial action necessary to reduce soil contamination and prevent recontamination of the Navy's property. Cleanup of some of the neighboring railroad property has yet to be completed; ATSF has large pits on their right-of-way in RASS 2 where soil has been removed but remediation has not been completed (Figure 3).

The Navy issued public notice of the ROD and RAP and solicited comments from interested parties; comments and Navy responses to comments were published in a final report issued on April 6, 1989 (Lee and others 1989b). Comments were received from EPA, National Oceanic and Atmospheric Administration (NOAA), CDFG, RWQCB, other local agencies, neighboring railroad and chemical companies, and interested individuals. The ROD also documented that the Navy consulted with EPA, RWQCB, CDFG, and the California Department of Health Services about the proposed RAP dated September 16, 1988, and that none of these agencies objected to the RAP.

The ROD mentioned the Section 7 (Endangered Species Act) consultation with the USFWS about the effect of the proposed remediation on special status species at the site. On August 23, 1988, USFWS issued a biological opinion stating that the proposed remediation of heavy metals was not likely to jeopardize the continued existence of the salt marsh harvest mouse, Least Tern (*Sterna antillarum*), or California Clapper Rail (USFWS 1988).

3.5 REGULATORY AND TRUSTEE AGENCY INPUT AND COMMENTS ON THE REMEDIAL ACTION

EPA and state regulatory agencies did not object to the ROD and RAP during development of the remedy, despite extensive opportunity for regulatory agency review, coordination, and consultation. Only RWQCB commented in writing on the proposed ROD and RAP during the public comment period. Neither EPA nor the other agencies signed the ROD. The Navy did receive comments from RWQCB and EPA expressing concerns about the proposed remedy for the site; however, these comments were received in 1991 and 1993, after the decision documents were finalized. The agencies commented on the use of TTLCs and STLCs as cleanup criteria, the depth and area of remediation, the potential for migration of contaminants off site, the need for toxicity testing, the extent of contamination in the passive remediation areas, success criteria for restoration of excavated areas, and the lack of clear triggers for additional remediation in the future. As lead agency, the Navy proceeded with the actions they considered to be appropriate to reduce risk at the site.

3.6 CONSENT DECREES

Following litigation to recover costs related to environmental cleanup of the four RASSs, the Navy signed consent decrees with 14 current and former landowners. Seven consent decrees were filed with the following parties:

- Allied Signal, Inc. (formerly Allied Chemical Corporation) on April 10, 1991
- CPC; O.E. Cooper; ESI Chemicals, Inc; and Earth Sciences, Inc. on November 5, 1991
- Getty Oil on October 17, 1990
- SNR on November 5, 1991
- ATSF; Santa Fe Southern Pacific Foundation; Santa Fe Land Improvement Company; and Santa Fe Industries, Inc. on November 13, 1991
- Sobotka, Joseph, and Wilda on September 11, 1990
- SPTC on October 11, 1991

As part of the settlement of all civil claims with the Navy, five of the seven consent decrees required remediation to be conducted on six adjacent properties to prevent recontamination of Naval Weapons Station SBD Concord. Allied Signal, Inc. agreed to reduce metals contamination in soil to California TTLC and STLC criteria in an area delineated in the consent decree and, if necessary, to implement remedial action to prevent recontamination of Navy property at concentrations exceeding TTLC and STLC criteria. CPC agreed to conduct appropriate remedial action at the surface impoundment, south field, and dike areas to prevent recontamination of Navy surface soil areas exceeding TTLC and STLC criteria and of groundwater beneath Naval Weapons Station SBD Concord that exceeds all federal and state regulatory standards. The railroad defendants agreed to remediate contaminated portions of three railroad rights-of-way to below TTLC and STLC criteria. All settling defendants, with the exception of Getty Oil and Santa Fe railroad defendants, contributed response costs to the United States for remediation of Navy property.

The Navy is evaluating whether neighboring property owners complied with the terms of the consent decrees and whether the Navy is liable for contamination derived from adjacent contiguous properties based on a new federal act (the Small Business Liability Relief and Brownfields Revitalization Act [Title 42 of the *United States Code* [42 U.S.C.] Section 9607(q)]).

3.7 NATIONAL PRIORITIES LIST STATUS

Naval Weapons Station SBD Concord was placed on the NPL in December 1994.

4.0 REMEDIAL ACTIONS

This section describes the remedial actions conducted at the site, including active remediation of the most contaminated areas and passive remediation and monitoring of contaminants left in place. The remedial actions identified in the ROD and RAP were fully implemented by the Navy. Remedy selection and remedial design are briefly described in Section 4.1. The active remediation and restoration of RASSs 1 through 4 are described in Section 4.2. The monitoring program implemented to evaluate the contaminants left in place in the passive remediation and monitoring areas is described in Section 4.3. The QEA conducted from 1995 to 1997 to determine whether contaminants left in place posed an ecological risk is briefly summarized in Section 4.4.

4.1 REMEDY SELECTION AND REMEDIAL DESIGN

The remedy selection and remedial action objectives for each RASS were defined in the RAP (Navy 1989a), as described in Section 3.5. Plans and specifications for the remedial actions were completed in 1990 (PRC 1990a, 1990b). Preremediation sampling was completed in 1991 at locations shown on Figure 11. The restoration and revegetation plan was completed in 1993 (ASRC Contracting Company [ACCI] 1993). The implementation of these plans is described in the following section.

4.2 IMPLEMENTATION OF REMEDIAL ACTIONS

The removal of contaminated soils and sediment from active remediation areas and site restoration were fully implemented in RASSs 1, 2, 3, and 4, as described in the following sections. Excavation was conducted by sampling intensively on a grid system within the active areas of each RASS and removing all soils that failed to meet cleanup criteria. Concentrations of metals in the four RASSs immediately before remediation and immediately after remediation are summarized in Tables 2 through 9; these data document that remedial actions in the active remediation areas achieved a significant reduction in metals concentrations and that cleanup criteria were generally met. Most locations in the RASS 3 active area sampled after remediation met cleanup criteria; however, some locations in RASS 3 sampled after remediation exceeded SARAC (Table 7). The detection of concentrations exceeding criteria at some locations is not surprising given the high variability of soil sampling results. Prior to remedial actions, the Navy conducted preremediation monitoring at locations shown on Figure 11. The Navy considers the remedial action in the active remediation areas to be successful in reducing risk and meeting remedial action objectives and goals. The remediated areas and postremediation monitoring locations are shown on Figure 12.

The Navy prepared an explanation of significant difference (ESD) in August 1994. The ESD presented the need for a temporary on-site dewatering facility to remove free liquids from sediments excavated from RASSs 1 and 2 before the sediments were shipped to a Class I landfill.

4.2.1 Remedial Action Subsites 1 and 2

Remedial actions in RASSs 1 and 2 consisted of characterizing metals contamination in the areas of the site designated for active remediation to determine the depths and extent of contaminated soil to be excavated. Tables 2 through 5 show the chemical concentrations in the active area before and immediately after remedial actions in RASSs 1 and 2. Following site preparation activities, contaminated soil was excavated and transported off site for disposal. RASS 1 was then backfilled with dredge spoil material, and both RASSs 1 and 2 were regraded and revegetated with native species.

The active remediation areas of RASSs 1 and 2 were surveyed and sampled in a grid pattern during June and July 1993. Some construction of haul roads and tidal barriers was also completed at that time. The active area survey grids were sampled in 6-inch sample intervals to a depth of 18 inches below ground surface (bgs) in RASS 1 and 42 inches bgs in RASS 2. Soil samples from RASS 1 were analyzed for arsenic, copper, and lead. Soil samples from RASS 2 were analyzed for arsenic, cadmium, copper, lead, selenium, and zinc.

The laboratory analyzed the samples in a specified sequence. Samples were first analyzed for total metals, followed by an analysis for soluble concentrations of metals where the total metal concentration was between the TTLC and 10 times the STLC. Soil samples that exceeded TTLCs or STLCs were considered contaminated and characterized as hazardous waste. The laboratory analytical results for metals were used to produce contamination maps that illustrated the lateral and vertical extent of contaminated soil at RASSs 1 and 2 based on TTLC and STLC criteria. The contamination maps also illustrated the sampling grid horizons (depth intervals) to be excavated. The contamination maps were finalized in May 1994. Excavation preparatory work was completed in July 1994, including construction of a soil dewatering pad, a decontamination pad, haul roads, and placement of wastewater holding tanks, and survey control points were established to monitor excavation and grading activities.

Excavation was started in August 1994 and completed in November 1994. Heavy equipment was used to remove surface layers of portions of RASSs 1 and 2. The grids in RASSs 1 and 2 were excavated to the deepest contaminated depth, as indicated on contamination maps. Surface soil was removed to a maximum depth of 18 inches bgs in RASS 1 and 42 inches bgs in RASS 2. An estimated 20,800 cubic yards of contaminated soil was removed from RASSs 1 and 2. The excavated soil was classified as

hazardous waste based on TTLC and STLC sample results and was transported to a Class I landfill for disposal.

The excavated area in RASS 1 (and the neighboring area remediated by Allied Signal, Inc.) was backfilled with sediment dredged from the Martinez Marina that met screening criteria using the wetland creation criteria (WCC) values for soils (RWQCB 1992). The Martinez Marina dredge sediment was first characterized from three composite samples collected from the backfill stockpile. Review of the results of the composite samples and extensive sampling and analysis performed by Allied Signal, Inc. led investigators to focus on four chemicals (copper, mercury, selenium, and zinc) that were present at concentrations approaching RWQCB's sediment screening criteria for WCC soils. Seventy-one additional discrete samples collected from Martinez Marina dredge sediment were also analyzed for copper, mercury, selenium, and zinc. Each discrete sample represented an area of 85 square feet by 2 feet thick, which equals a volume of approximately 500 cubic yards. Analysis of the 71 discrete Martinez Marina sediment samples showed that copper, selenium, and zinc were below WCC values. Mercury was the only chemical that exceeded the WCC value (0.35 mg/kg) in any of the discrete samples. Sampling grids at Martinez Marina that exceeded the WCC value for mercury were excluded and not used as backfill at RASS 1. The Martinez Marina dredge sediment was amended with sand, so that sand comprised 8 percent of the backfill material. No organic amendments were added to the backfill. Sand was obtained from Tidewater Sand and Gravel Company in Oakland, California. A composite sample of the sand contained the following metals concentrations (mg/kg dry weight): arsenic at 5.4, cadmium at less than 0.5, chromium at 43.4, copper at 10.9, lead at less than 20.0, mercury at less than 0.15, nickel at 59.1, selenium at less than 0.5, and zinc at 47.8. Volatile organics, semivolatile organics, polychlorinated biphenyls (PCB), and pesticides were not detected in sand samples.

Backfilling and initial grading of the site was completed in November 1994. Site grading was conducted to smooth out excavated and backfilled areas in preparation for revegetating the site. Revegetation protocol for the active remediation areas at RASSs 1 and 2 included planting and seeding, irrigation, erosion control, and monitoring. The revegetation activities occurred over many months beginning in spring 1995 and extending into summer 1996. The lowest elevations (lower marsh region) were planted with pickleweed (*Salicornia virginica*) plugs, fat hen (*Atriplex patula*), and alkali heath (*Frankenia grandifolia*) tubelings. The plugs and tubelings were transplanted from nearby marsh plant communities. Marsh regions of RASSs 1 and 2 with a 1-foot rise in elevation over the lower marsh were also seeded with marsh grindelia (*Grindelia humilis*). The area of transition between the marsh and upland zones in RASS 2 was revegetated with a combination of marsh grindelia tubelings, coyote bush tubelings, and beardless wild rye (*Elymus triticoides*) and meadow barley (*Hordeum*) seeds.

Two earthen mounds were constructed in RASS 1 to serve as a refuge to wildlife, specifically the salt marsh harvest mouse, during periods of high tides. The "refugial mounds" were vegetated with two plant communities: one on the slopes and another on the top. The slopes were planted with marsh grindelia tubelings and seeded with beardless wild rye, meadow barley, purple stipa (*Stipa pulchra*), and California brome (*Bromus carinatus*). The tops were planted with coyote brush and seeded with the same grasses as the slopes.

4.2.2 Remedial Action Subsite 3

The remedial action at RASS 3 was begun in May 1993 and concluded in July 1994. The RASS 3 remedial action consisted of characterizing site contamination to determine the depths and extent of soil excavation, excavating the contaminated soils, and regrading and revegetating the site (ACCI 1994). Tables 6 and 7 show the chemical concentrations in the active area before and immediately after the remedial action in RASS 3; some contamination concentrations detected above SARAC occurred in the postremediation samples.

Remediation of metals-contaminated soils in RASS 3 began in May of 1993, with a survey of a sampling grid pattern over the RASS 3 active area. The first phase of soil sampling and analysis was conducted from May to October 1993 with approximately 3,000 samples collected to a grid depth of 2.0 feet bgs. The second phase of sampling and analysis was conducted in March 1994. Approximately 1,000 samples were collected from 4 feet bgs in the grids that revealed metals contamination in the 2.0-foot-bgs sample interval. Soil samples were analyzed for arsenic, cadmium, copper, lead, selenium, and zinc (ACCI 1994).

The laboratory analyzed the samples in a specified sequence. Samples were first analyzed for total metals, followed by an analysis for soluble concentrations of metals where the total metal concentration was between TTLC and 10 times the STLC. Soil samples that exceeded TTLCs or STLCs were considered contaminated and characterized as hazardous waste. Another set of screening values, referred to as SARAC, were developed for cadmium, copper, and zinc in RASS 3. SARAC for metals were less than their respective TTLCs and STLCs. As a result, soil samples exceeding SARAC were also considered contaminated; however, the samples were not characterized as hazardous waste. The laboratory analytical results for metals were used to produce contamination maps that illustrated the contaminated soil grids and grid horizons (depth intervals) to be excavated based on the TTLCs, STLCs, and SARAC.

During soil sampling for metals characterization in the north-central region of the RASS 3 active area, samplers encountered a black tar-like substance, which was confirmed through analysis to be petroleum hydrocarbon contamination containing concentrations of TPH as extractables and minor concentrations of benzene, toluene, ethylbenzene, and total xylenes and polynuclear aromatic hydrocarbons. This region of RASS 3 was investigated to delineate the preliminary boundaries of hydrocarbon contamination (PRC 1993). Although this investigation determined that hydrocarbon contamination extended beyond and beneath the RASS 3 metal contamination-based remediation area boundary, the remediation plan was not modified to include removal of hydrocarbon-contaminated soils.

Excavation preparatory work was completed in March 1994 when the second phase of site characterization samples were being analyzed. Excavation preparatory work included extending the RASS 3 haul road, implementing surface water runoff control measures, and establishing and maintaining survey controls. The horizontal and vertical extent and the cut depth of each grid was staked and marked with information derived from the laboratory analytical data and the contamination maps (ACCI 1994).

Excavation was started in April 1994 and was completed in June 1994. Each grid was excavated to the deepest contaminated depth, as indicated on the contamination maps. The excavation process usually involved several cuts for each grid to allow for the segregation, to the extent feasible, of hazardous (TTLC and STLC criteria) and nonhazardous (SARAC) soils. Hazardous waste soil was transported to a Class I landfill for disposal, and nonhazardous waste soil was transported to a Class II landfill for disposal. A total of 18,236 cubic yards of material was excavated (ACCI 1994).

Contaminated grids were generally excavated to depths ranging from 0.5 to 3.5 feet bgs, as dictated by the deepest contaminated layer. Thirty-eight grids were found to be contaminated at 3.5 feet bgs and were excavated to either 5.0 or 5.5 feet bgs. Grids in the wetland area on the west side of RASS 3 were excavated below the groundwater table (to approximately 4 feet bgs), resulting in ponded water in the grids after excavation; the source of the water was likely groundwater and tidal influx of surface water from under the railroad trestle. This area, referred to as the RASS 3 Pond, is slowly filling in with a dense stand of cattails.

A steel pipeline was uncovered while excavating in the north-central boundary of the active area. This pipeline is north and west of the hydrocarbon contamination characterized in RASS 3 (PRC 1993). The pipeline may be associated with two 8-inch-diameter Getty Oil pipelines that parallel the northern border of RASS 3. The pipeline's location was surveyed for the RASS 3 as-built drawings. This area was graded uniformly, so the pipeline was not a topographic high spot after excavation.

Site grading after soil excavation smoothed the vertical cuts of the checkerboard-patterned excavations and contoured a smooth transition from the upgradient (east) side to the downgradient (northwest) side. In addition, some cutting was performed to provide a defined flow channel within Nichols Creek. Grading was completed in June 1994 (ACCI 1994).

After grading was completed, 5 acres of excavated area was seeded during June 1994. The seed mix included beardless wild rye, purple stipa, California brome, and red fescue (*Festuca rubra*). The area was covered with straw after seeding was completed (ACCI 1994). All remediation activities were completed by late July 1994.

4.2.3 Remedial Action Subsite 4

Site remediation was conducted at RASS 4 to remove metals-contaminated and acidic soils from the areas designated for active remediation areas. The remedial action at RASS 4 included two rounds of surveying and sampling, clearing and grubbing followed by soil removal and disposal, and revegetation of the site (PRC 1994b). Tables 8 and 9 show the chemical concentrations in the active area before and immediately after remedial action in RASS 4.

The active areas in RASS 4 were divided into grids that were surveyed and sampled. Soil samples were analyzed for arsenic, cadmium, lead, and selenium and pH. Analytical procedures were conducted in the same manner as for the other RASSs. Soils with metal concentrations exceeding TTLCs or STLCs were considered contaminated. As a result, the soil was excavated from the site as hazardous waste and disposed of at a Class I landfill. Soils with a pH of less than 5.0 were considered acidic. As a result, the soil was excavated from the site and transported to a Class II nonhazardous waste landfill for disposal. The first round of surveying and sampling was conducted during late January and February 1993. The second round of surveying and sampling was conducted during October 1993. Results of the first and second round of sample analysis are illustrated on a contamination map that presents the intended depth and lateral extent of contaminated soil removal.

Clearing and grubbing at the site was conducted during early December 1993, and included clearing of contaminated areas of brush as well as construction of haul roads, decontamination and dewatering pads, and soil staging areas. Following approval of the contamination map by the Navy, the remediation contractor began excavation and removal of contaminated soil in mid-December 1993. Soil excavation continued through January 1994 but was discontinued in February. Excavation resumed and concluded in March 1994. Contaminated soil at RASS 4 was excavated from approximately 1 acre of the active

remediation areas, to a mean depth of 18 inches bgs. An estimated 3,000 cubic yards of contaminated soil was removed. No backfill soil was imported to RASS 4 (PRC 1994b).

The site was regraded and revegetated after excavation with grass seed, nursery grown tubelings of selected plants (primarily coyote brush), and plants harvested from adjacent areas. Three plant species were harvested from the adjacent marsh, including common tule (*Scirpus acutus*), common cattail, and salt grass (*Distichlis spicata*). Transplant elevations were measured, generally matching the elevations for each species in the adjoining natural marshland. Approximately 1,199 tubelings of coyote brush were planted in April 1994 in the upland areas of the site. The plants were irrigated periodically during the first growing season. A drip irrigation system was installed in June 1994 and stayed in place until fall 1995 (PRC 1994b).

4.3 LONG-TERM MONITORING OF CONTAMINANTS LEFT IN PLACE

A long-term monitoring program was established as part of the remedy to monitor potential migration and ecological effects of contaminants left in place. The monitoring program had very general objectives and underwent significant revision during its implementation. The monitoring program is described in the following sections; an evaluation of the monitoring program results and effectiveness is provided in Appendix D and is summarized in Section 6.3.

4.3.1 Remedial Action Monitoring Program

The original WES monitoring plan (Lee and others 1989a) was developed to monitor contaminants left in place at the site. The monitoring plan was developed for a 30-year period, with annual monitoring for the first 5 years and monitoring every 5 years for the remaining 25 years. The unremediated portion of the site was divided into passive remediation and monitoring areas, and sampling locations were focused on the borders of the passive and active remediation areas (Figure 11). The objectives of the WES monitoring plan included:

- Objective 1: To establish baseline conditions
- Objective 2: To assess the impact of the active remediation on Suisun Bay
- Objective 3: To determine if the area actively remediated is recontaminated and if so, the extent of recontamination
- Objective 4: To determine if the contaminants migrate from the area passively remediated and if so, the extent of contaminant mobility

- Objective 5: To monitor wetland and upland restoration and revegetation
- Objective 6: Determine if the groundwater is impacted by the contamination

To address regulatory agency concerns, a seventh objective (objective 7) was added (PRC 1991a, 1991b): determine whether the uncharacterized areas in the monitoring area are contaminated and, if so, the level of contamination.

The original monitoring program included two phases. Phase 1 included soil, sediment, surface water and groundwater chemistry; clam bioaccumulation; and vegetation, invertebrate, and wildlife characterization. Phase 2 monitoring of wildlife bioaccumulation was to be triggered by results of phase 1; how this triggering was to be implemented was not clearly defined.

Site monitoring protocol (PRC 1991a) provided the details on the methodology for the implementation of the monitoring program. The monitoring contingency plan (PRC 1991b) provided details for deviations from the monitoring program to address specific contingency situations and the analysis of additional parameters. The monitoring contingency plan stated that, if monitoring sample results exceeded baseline sampling results, phase 2 bioaccumulation parameters would be implemented. If phase 2 samples exceeded baseline and reference area conditions, then the Navy would consider initiating an RI and FS.

The Navy and regulatory and trustee agencies held numerous meetings between 1995 and 1997 to discuss the monitoring program. Based on initial data, the monitoring contingency plan could not be implemented because of the high level of variability in the preremediation baseline conditions data set. The Navy and the agencies informally agreed to revise the monitoring program to collect monitoring data for several years to better assess variability in contamination concentrations across the site and to conduct a QEA to evaluate the risk from remaining contaminants (Sections 4.3.4 and 4.4).

4.3.2 Preremediation Monitoring

In accordance with the provisions of the WES monitoring plan (Lee and others 1989a), the Navy collected environmental samples and performed ecological surveys in 1991 to establish preremediation conditions in the Litigation Area. The results of the sampling event are summarized in the baseline conditions report (PRC 1994a). The baseline conditions results are fully evaluated in this five-year review to assess changes at the site. Figure 11 shows the locations sampled during the preremediation monitoring event.

4.3.3 During Remediation Monitoring

Limited monitoring was conducted between 1991 and 1993 during the remedial actions to evaluate nature and extent and migration of contaminants during the construction phase.

4.3.4 Postremediation Monitoring

As a result of data collected before and during remediation, additional information on site conditions was obtained that called into question some aspects of the design of the postremediation monitoring program. The Navy met with EPA and other agencies to discuss concerns about the monitoring program and to develop a revised monitoring program. Some of the concerns included (1) the biased nature of the sampling design, (2) the lack of samples in sloughs or ditches and other portions of the site, (3) the high variability of existing chemistry data and the feasibility of assessing changes using the original design, and (4) the artificial distinction between the monitoring and passive areas since both areas were contaminated. The Navy and regulatory agencies agreed to redesign the monitoring program and to slightly alter the monitoring objectives. The revised objectives included (PRC 1997a):

- Objective 1: Collect data that will assist in evaluating long-term changes in site conditions
- Objective 2: Evaluate potential contaminant migration to Suisun Bay (groundwater, surface water, and sediment)
- Objective 3: Determine if the active remediation areas become recontaminated; if so, determine the extent of recontamination and potential sources
- Objective 4: Evaluate contaminant migration in the unremediated areas
- Objective 5: Monitor the overall habitat quality of the site, including the success of the restoration and use of the site by special status plants and animals
- Objective 6: Determine if the groundwater is impacted by the contamination

The Navy agreed to add many more sampling locations across the site, including in the sloughs and ditches where few samples had been collected. The design was also changed to include randomly selected sampling locations and single, rather than triplicate, samples at each location. The Navy and the regulatory agencies agreed that this approach would allow for better characterization of contaminant levels at a broader spatial scale across the site.

After remediation, the Navy began annual monitoring and prepared after-remediation (year 1, year 2, year 3, year 4, and year 5) remedial action monitoring reports (PRC 1996b, 1997a; TtEMI 1998, 1999,

2000a). Figure 12 shows the locations sampled during the postremediation monitoring events. Field monitoring activities included:

- Chemical analysis of soil, sediment, and surface water samples
- Ecological characterizations of avian, small mammal, and plant receptors
- Monitoring of revegetation success in remediated areas
- Toxicity tests (not annually)
- Special studies to address contaminant migration concerns

The dates of postremediation monitoring activities during years 1 through 5 at the Litigation Area are listed below.

Activity	Year 1	Year 2	Year 3	Year 4	Year 5
Soil, sediment, and surface water sampling	August to September 1995	December 1996 to March 1997	May to June 1997	June to July 1998	May to June 1999
Vegetation surveys and revegetation monitoring	July 1995 to January 1996	June to October 1996	July to September 1997	August to November 1998	August to October 1999
Small mammal surveys	June to September 1995	July to November 1996	September to October 1997	September to October 1998	September to October 1999
Avian and Black Rail surveys	June to August 1995 and December 1995 to February 1996	April to July 1996	June 1997	May to June 1998	April to May 1999
Aerial photographs	June 1995	August 1996	July 1997	September 1998	September 1999
Storm event sampling	--	--	--	--	January to April 1999
Characterization of flow and migration through Nichols Creek	--	--	--	March 1998	--
Toxicity tests	--	--	June 1997 (urchin porewater test)	June to November 1998 (topsmelt sediment-water interface test)	--

Note:

-- Activity was not conducted during that monitoring event.

Statistical methods were used to determine the number of soil, sediment, and surface water samples necessary to answer specific monitoring questions. On the basis of evaluation of data from year 1

monitoring, the Litigation Area was divided into 16 spatial units (Figure 12). Priorities were established for sampling of the spatial units on the basis of the level of concern about concentrations of contaminants, and the appropriate number of samples to be collected from each unit was identified using statistical power analyses. To allow comparison of data, existing sampling locations used during the year 1 monitoring event and QEA sampling activities were resampled during year 2. If the number of existing sampling locations within each spatial unit was less than the number of samples required to detect significant changes, as indicated by the power analyses, sampling locations were added for the year 2 and subsequent sampling activities. A stratified random approach was used to select the additional sampling locations within each spatial unit. For that reason, sample size and some sampling locations for year 1 differ from those for years 2, 3, 4, and 5. Sample sizes were increased after year 1.

While the number of samples was determined by priority and statistics, a random grid system was used to select actual sampling locations. As originally devised in the WES monitoring plan (Lee and others 1989a), the spatial units are overlain with a grid system that divides the site into 100-by-100-foot grids. The grid system facilitates consistent sampling over time and allows analysis of data by a geographic information system (GIS). Each 100-by-100-foot grid in a spatial unit was assigned a number. New sample grids were selected randomly in areas that needed additional samples. The selected grids were designated as the sampling locations for that spatial unit. The sampling location grids established for year 1 and added for year 2 remained consistent for all subsequent monitoring years. A different random quadrat within the 100-by-100-foot grid was sampled each year for soil locations to characterize contamination on the scale of the grid. For sediment and surface water locations, a permanent station was established in a ditch or slough closest to the stake, and the same location was sampled each year.

Based on the previous years' monitoring results and discussions with the regulatory agencies, additional sampling or special studies were conducted to address concerns about the site. These additions or changes included:

- Year 2: Sampling locations were added in areas of concern, such as the slough, that had not been adequately represented in the original monitoring design. Analysis of mercury in surface water, soil, and sediment samples collected in RASS 4 was added because the QEA (PRC 1997c) identified mercury as a COC in RASS 4. Analysis of total organic carbon (TOC) in soil and sediment samples was added to evaluate the mobility of metals in soil.

- Year 3: Turbidity and salinity measurements were added to surface water samples, in addition to pH, conductivity, temperature, and dissolved oxygen.

- Year 4: Additional studies were implemented, including profiles of the mosquito abatement ditches and winter surface water sampling in Nichols Creek. Filtered (dissolved) surface water chemistry samples were added at a subset of the surface water sampling locations.

- Year 5: Additional surface water studies included a winter storm event sampling, which included both filtered and unfiltered surface water sampling, and the installation of a sensor to measure turbidity and other parameters; hardness was added to the parameters analyzed. A pollen and lead study was conducted using lead-210 and palynological techniques to determine sediment accretion rates on the marsh surface.

Ecological characterization and toxicity assessment activities have also undergone some changes or additions, including:

- Year 2: The characterization of benthic invertebrates was discontinued after year 1; because of natural variability in the composition of the benthic community, that endpoint was not considered a reliable indicator of contaminant effects. New trapping grids were added to the small mammal characterization in year 2 to assess the recolonization of remediated areas by small mammals.

- Year 3: Sea urchin development tests were conducted on pore water from nine locations in Lost Slough and in the RASS 3 pond area.

- Year 4: Special status plant species were mapped using global positioning system (GPS) and sediment-water interface toxicity tests using topsmelt (*Atherinops affinis*) embryos were conducted on 10 sediment samples from Lost Slough.

In 1995, the Navy finalized the plan for monitoring the success of the revegetation and restoration of the actively remediated areas (H.T. Harvey and Associates, Inc. 1995). This plan established success criteria for the different revegetation efforts in the active remediation areas of each RASS. Monitoring of revegetation success was conducted in each year of the annual monitoring.

4.4 QUALITATIVE ECOLOGICAL ASSESSMENT

A QEA was performed at the Litigation Area during 1995 through 1997 to evaluate whether contaminants remaining at the site after remedial actions presented a significant risk to ecological receptors (PRC 1997c). The QEA was completed before the release of formal guidelines for conducting ERAs under CERCLA (EPA 1997a); however, the QEA was consistent with the available guidance (EPA 1992b). The QEA included a screening-level ERA, in addition to field and laboratory components such as bioassays, which are typically part of a BERA. As a result, The QEA was an intermediate between a screening-level ERA and a BERA and satisfies all requirements specified for Steps 1 and 2 of the current eight-step ERA process (EPA 1997a).

To evaluate risk to receptors, the QEA used data collected in 1991 during the baseline monitoring and data collected in 1996 under the year 1 postremediation monitoring and QEA activities. Approaches included (1) comparison of chemical concentrations in soil, sediment, surface water, pore water, and leachate with available screening values; (2) surveys of plants and animals at the site; (3) evaluation of data on tissue residue in plants, invertebrates, and vertebrates; (4) toxicity tests (bioassays); (5) food-chain modeling; and (6) reviews of published literature. Twelve assessment endpoints, ranging from plants to higher-trophic-level receptors, were identified for specific evaluation during the QEA.

Inorganic chemicals were frequently detected at concentrations above screening values and were generally considered to pose the greatest risk to receptors; organic chemicals were rarely detected and were not considered to pose a significant risk. Areas identified as posing the greatest risk based on chemical screening were the southeastern portion of RASSs 1 and 2, the southern reach of the main slough in RASS 1, and the Nichols Creek area in RASS 3.

The QEA concluded that plants exposed to high concentrations of some inorganic chemicals may be subject to significant risk. The small population of endangered soft bird's beak just northwest of the active remediation area in RASS 1 was thought to warrant special concern; however, in general, populations of marsh and upland plants throughout most of the Litigation Area were not considered at risk from site contaminants. It was recommended that continued monitoring of special status plant populations should be conducted under the long-term monitoring protocol.

Risk to aquatic invertebrates was evaluated by comparing chemical concentrations in wetland soil, sediment, surface water, pore water, and leachate with screening values derived for aquatic taxa, such as effects-range low (ER-L) and ambient water quality criteria (AWQC). On the basis of that evaluation, risk to aquatic invertebrates at the site was considered significant. Although the total concentrations of chemicals in environmental media may not be available for uptake by receptors, concentrations of chemicals in pore water and leachate samples indicate that invertebrates at the site may be exposed to toxic levels of soluble chemicals. Toxicity tests based on whole sediment (amphipod bioassays) indicated some reduction in survivorship; however, results fell within accepted ranges when evaluated on the basis of the reference envelope approach developed by RWQCB and others (State of California Water Resources Control Board [SWRCB] 1998).

Risk to fish at the site was evaluated by comparing concentrations in surface water and pore water with AWQC. On the basis of that evaluation, the potential adverse effects of chemicals on fish exposed to maximum concentrations at the site were determined to be significant for fish that inhabit the site. A

sediment-water interface test using topsmelt embryos that was conducted during a subsequent monitoring event indicated no adverse effects on hatchability of fish embryos; however, these tests were not conducted on the most contaminated sediments at the site. Risk to migratory fish or fish that temporarily inhabit the site such as the special status delta smelt (*Hypomesus transpacificus*) and Chinook salmon (*Oncorhynchus tshawytscha*) was considered to be low.

Risk to higher-trophic-level birds and mammals was evaluated by comparing estimated site-specific ingested doses of contaminants with toxicity reference values (TRV) derived by the Navy through reviews of toxicological literature (EFA West 1998). Relatively conservative high and low doses were calculated using a food-chain model with different assumptions related to such parameters as body weight, ingestion rate, prey composition, and concentrations of contaminants in prey and soil. The high and low doses were compared with high and low TRVs using a hazard quotient (HQ) approach. On the basis of those evaluations, none of the higher-trophic-level assessment endpoint species was considered subject to significant immediate risk from any organic contaminants or most inorganic contaminants (most HQs based on low dose/high TRV were less than 1.0). In a few locations, HQs (low dose/high TRV) for the salt marsh harvest mouse exceeded 1.0 for arsenic and selenium. Under very conservative assumptions about exposure and effects, individuals of most of the species evaluated were found to be subject to some risk (HQs based on high dose/low TRV were greater than 1.0). That risk was greatest in the southeastern portion of RASS 1, west of the remediated area. Mercury detected at RASS 4 was further evaluated under the monitoring program to assess whether mercury exists in a bioavailable form that could affect higher-level receptors. The mercury evaluation, which was included in the year 4 monitoring report (TtEMI 1999), showed no significant risk to birds or mammals in RASS 4. Rodent tissue collected from RASS 4 did not contained mercury; it was concluded that mercury is not bioaccumulating in animals at the site and does not pose a risk to higher-trophic-level birds or mammals.

5.0 COMPONENTS OF THE FIVE YEAR REVIEW

This section presents the five-year review team and community involvement activities and briefly outlines components of the review, including major tasks, data utilized, use of reference areas, and conceptual site models (CSM).

5.1 FIVE YEAR REVIEW TEAM

The Navy and its contractors worked closely with the regulatory and trustee agencies to develop the approach for the review. Many meetings were held with the regulatory and trustee agencies during 2000 and 2001 to discuss the review; meeting minutes have been included in the administrative record. The Navy's review team is presented in the table below.

Navy remedial project manager	Gilbert Rivera
Navy quality assurance (QA) officer	Narciso Ancog
CLEAN program manager (Tetra Tech EM Inc. [TtEMI])	Daniel Chow
Installation coordinator (TtEMI)	John Bosche
Project manager (TtEMI)	Mary Gleason, Ph.D.
Project QA manager (TtEMI)	Ron Ohta
Project health and safety coordinator (TtEMI)	Conrad Sherman
Field team leader (Uribe and Associates)	Bill White
Analytical coordinator (TtEMI)	Kevin Hoch
Database manager (TtEMI)	Wing Tse
Ecological risk assessors (TtEMI)	Ray Bienert, Ph.D. Joanna Canepa Cindi Rose Keith Pierson, Ph.D. Fionna Mowat, Ph.D. Richard Vernimen
Human health risk assessors (TtEMI)	Lynne Haroun Aileen Mendoza
Hydrogeologist (TtEMI)	Rik Lantz
Regulatory support (TtEMI)	Bill Westerfield
Community relations specialist (TtEMI)	Marie Rainwater

5.2 COMMUNITY INVOLVEMENT ACTIVITIES

Pursuant to requirements under CERCLA, the public has been informed of activities related to the five-year review.

5.2.1 Public Notice

A public notice of the beginning of the five-year review process was published in the *Contra Costa Times* on October 19, 2000.

5.2.2 Community Summary Report

The Navy prepared a draft report summarizing the findings and conclusions of the five-year review for the community. The Navy submitted the draft summary report to the Restoration Advisory Board members and information repository on February 19, 2002 (TtEMI 2002).

Appendix C of this five-year review includes the draft final community summary report. In addition, a complete copy of the draft final five-year review assessment report will be available to the public in the information repository at the Concord public library.

5.3 COMPONENTS OF THE FIVE-YEAR REVIEW ASSESSMENT

The Navy worked closely with the regulatory and trustee agencies to develop a work plan and approach for the five-year review that was consistent with available guidance (Navy 2001; EPA 2001). However, it should be noted that the guidance documents were still internal drafts at the time the work plan was developed. The components of the five-year review, methods, and approaches were identified in the work plan (TtEMI 2000d). In addition, the regulatory and trustee agencies reviewed the work plan and discussed their comments with the Navy. The following components formed the basis of the five-year review:

- **Review of Site Documents:** A list of site documents reviewed is provided in Appendix A. The documents that were used to support remedial or risk management decisions were reviewed to document past investigations, identify assumptions and rationale for prior decisions, and provide a complete chronology for the site (Section 3.0). The review included documents that formed the basis of the selection of the remedial action; documents related to the design, implementation, and maintenance of the remedy; and supporting legal documents and correspondence.

- **Site Inspection and Interviews:** Although a formal site inspection tour was not required because of the continued presence of the Navy and its contractors at the site, the Navy invited representatives of the regulatory and trustee agencies on a site inspection tour (July 27, 2001) after the draft five-year report was submitted. The Navy did not conduct interviews for the five-year review because available site documentation provided sufficient information to conduct the review.

- **Review of Operations and Maintenance Costs:** A breakdown of the costs required to implement and maintain the remedy was compiled to evaluate the cost effectiveness of the remedy.

- **Review of ARARs and Other Guidance:** The Navy issued a letter on February 5, 2001, to the State of California requesting identification of ARARs or "to be considered" (TBC) information that bear on the protectiveness of the remedy selected in the ROD and RAP. The state has not yet replied to the Navy's request. For this review, the Navy examined standards that were identified as ARARs in the ROD and RAP, newly promulgated standards, and TBCs that question the protectiveness of the remedy.

- **Review of Monitoring Objectives and Results:** The preremediation and postremediation monitoring results were summarized and evaluated to assess changes at the site. The monitoring objectives and the effectiveness of the monitoring program were also evaluated to make recommendations about future monitoring.

- **Evaluation of Existing Sources and Migration of Contaminants:** The potential for existing off-site sources of contamination to Navy property was evaluated through a file review of current environmental investigations at neighboring facilities and field observations. Migration of contaminants in soil, sediment, surface water, and groundwater was evaluated using data from the monitoring program and special studies conducted to date.

- **Screening-level HHRA:** The Navy conducted a screening-level assessment that included a residential and industrial receptor in a Tier 1 assessment that evaluated all detected chemicals. Results for these receptors will provide information that can be used to support decisions about the need for restricted use or institutional controls. The Tier 2 assessment focused on more realistic, current receptors identified at the site using a mosquito abatement worker as a representative.

- **BERA:** The Navy conducted a screening-level ERA of organic chemicals and a BERA that focused on the inorganic chemicals of concern at the site. The BERA included an evaluation of numerous assessment and measurement endpoints to evaluate risks to plants, aquatic invertebrates and fish, and birds and mammals.

5.4 OCTOBER 2000 FIELD INVESTIGATION TO FILL DATA GAPS

The Navy agreed to collect additional data to fill gaps identified during the development of the approach and work plan for the five-year review; field work was conducted in October 2000.

To support the BERA, the following field activities were conducted:

- Collection of sediment for conducting amphipod (*Eohaustorius estuarius*) 10-day bulk sediment bioassay
- Collection of sediment for conducting amphipod (*Hyalella azteca*) 14-day bulk sediment bioassay
- Collection of invertebrate (clam) tissue samples
- Collection of sediment chemistry samples collocated with amphipod bioassays and clam tissue samples
- Collection of surface water chemistry samples

To support the evaluation of migration of contaminants, the following field activities were conducted:

- Vertical delineation of metals concentrations on the marsh surface using x-ray fluorescence (XRF)
- Vertical delineation of metals concentrations in ditches and sloughs using XRF
- Collection of surface water chemistry samples on incoming and outgoing tides
- Mapping of erosional areas in RASS 3

Field activities for the new data collection effort were described in detail in the draft final FSP (TtEMI 2000b), including sampling design, sample sizes, field procedures, and sample handling. A draft final QAPP (TtEMI 2000c) included a discussion of data quality objectives (DQO), quality assurance and quality control (QA/QC) issues, and standard operating procedures (SOP). Sampling locations for the October 2000 field investigation are shown on Figure 14.

The Navy did not perform the *Neomysis* surface water bioassay proposed in the work plan because field work was conducted too late in the season (October 2000) to collect gravid females for this bioassay (Appendix G for further discussion).

5.5 DOCUMENTS AND DATA INCLUDED IN THE FIVE-YEAR REVIEW

The five-year review was based on a review of the site documents listed in Appendix A that provided background on the site and decisions about remediation. Site-specific chemical and ecological data from the monitoring program and a variety of studies conducted to date at the Litigation Area were also

evaluated. All of this data has been validated and data validation information is presented in the primary sources. The major sources of data included:

- **Baseline Conditions Report:** Preremediation monitoring was conducted in 1991 and included chemical analysis of soil, sediment, and surface water; bioaccumulation studies; and ecological characterization, as described in Section 4.3 (PRC 1994a).

- **Years 1 through 5 Monitoring Data:** Annual postremediation monitoring was conducted and reported for year 1 (PRC 1996b), year 2 (PRC 1997a), year 3 (TtEMI 1998), year 4 (TtEMI 1999), and year 5 (TtEMI 2000a). Data include chemical analysis of soil, sediment, and surface water; ecological characterization; and special studies, as described in Section 4.3.

- **QEA (PRC 1997c):** The QEA included collection of data on nature and extent of contamination, toxicity tests, bioavailability, and bioaccumulation, as described in Section 4.4. Sampling for organic chemicals was conducted in 1996 under the QEA at the locations shown on Figure 13.

- **Other Special Studies:** The review included evaluation of other data such as groundwater data from pre- and postremediation sampling and special studies conducted under the monitoring program, such as the tidal influence study (PRC 1997b). These documents are referenced as needed to identify the source of the data included in this review.

- **October 2000 Field Investigation:** Additional data were collected to fill data gaps, as described in Section 5.4 and the FSP (TtEMI 2000b).

5.6 CONCEPTUAL SITE MODELS

The CSMs were discussed and agreed on with the regulatory and trustee agencies during the work plan development phase. The CSM for the HHRA is presented on Figure 15 and is discussed in detail in Appendix F. The CSM for the BERA is presented on Figure 16 and is discussed in detail in Appendix G. In addition, diagrams presenting information on contamination sources, potential transport pathways, and ecological exposure routes are presented separately for each RASS (Figure 17 through 20); these figures distinguish between major and minor pathways.

5.7 REFERENCE AREAS

During the RI and FS, two reference areas were identified and used for comparative purposes to evaluate conditions at the site and, in the case of RASS 3, to identify cleanup criteria. The upland reference area is composed of upland soils, next to Nichols Creek and upgradient from the CPC plant source (Figures 2 and 10 [Site BK133]). The area was also used as an upland reference area in the QEA (PRC 1997c) and during the monitoring program (referred to as Unit 16). Concentrations of chemicals in the upland

reference area have typically been much lower than those concentrations in the rest of the Litigation Area upland habitat.

A shoreline reference area established for the RI and FS was west of the Litigation Area (Figure 2). During the first year of monitoring and the QEA, it was determined that metal concentrations in the shoreline reference area were above screening values and that wetland habitat was not similar to the Litigation Area (PRC 1997c). In addition, the Navy evaluated the suitability of neighboring marshes along the southern coast of Suisun Bay for use as a marsh reference area. The southern shore of Suisun Bay is heavily industrialized with chemical plants and oil refineries on both sides of Naval Weapons Station SBD Concord. The northern shore of Suisun Bay is less industrialized, but differs in hydrology and species composition of the wetland habitat; it therefore was not considered a suitable reference area. Regulatory and trustee agencies agreed that finding an off-site, unaffected area with similar habitat was not feasible. A new marsh reference area was established in 1995 in the northwestern corner of the Litigation Area in wetland habitat that is more typical of the rest of the site (Figures 2 and 10). Relatively low concentrations of metals have been measured in the marsh reference area (also referred to as Unit 1) during the monitoring program, and the area is not considered to be significantly affected by historical spills at the site. The area is considered a suitable reference area for comparative purposes for the evaluation of data from the marsh surface in the rest of the Litigation Area.

A new slough reference area was proposed at the mouth of the Lost Slough, adjacent to Suisun Bay (Figures 2 and 10), during the development of the five-year review work plan for use in the evaluation of new chemical and biological data collected in the sloughs and ditches during the October 2000 field investigation. Low concentrations of metals were detected in nearby sampling locations such as R01SH206 during the monitoring program, and this area at the mouth of the slough is very similar habitat to the rest of Lost Slough that winds through the site. The slough reference area was used for comparative purposes to evaluate samples from the affected portion of the slough in a risk management context.

Available chemical and biological data from the upland, marsh, and slough reference areas and their suitability as reference areas are discussed further in the BERA (Appendix G).

5.8 SPATIAL UNITS AND HABITAT AREAS

Each RASS was divided into spatial units based on habitat type and topography for sampling under the monitoring program (Figure 12 and Appendix D). These spatial units are described below:

- **Marsh Surface Reference Area (Unit 1):** For comparative purposes, the northwestern corner of the marsh was proposed as the marsh reference area in 1995. The unit is relatively far from the source of contamination and probably represents regional ambient conditions related to deposition of chemicals from Suisun Bay or other sources.

- **Northern Marsh Surface (Unit 2):** The northern marsh surface unit is bordered on the north by Suisun Bay, on the west and south by Lost Slough, and on the east by General Chemical property; the unit is tidally inundated.

- **Northern Ditches (Unit 3):** The northern marsh is bisected by a series of manmade mosquito ditches where sediment and surface water has been sampled.

- **Southwestern Marsh Surface (Unit 4):** The area lies on the southwestern side of RASS 1 and is bordered by the northern and central reaches of Lost Slough on the north and east, Stevens road on the west, and the railroad track berm on the south; the unit is tidally inundated.

- **Southwestern Ditches (Unit 5):** The southwestern marsh is bisected by a series of manmade mosquito ditches that are tidally inundated.

- **Central Marsh Surface (Unit 6):** The central marsh is just west of the RASS 1 remediated area (Unit 8), bordered by the transitional upland area of Unit 12 to the south, Lost Slough to the west, and to the north is separated from the northern marsh (Units 2 and 3) by a small slough.

- **Central Ditches (Unit 7):** The central marsh is bisected by a series of manmade mosquito ditches that are tidally inundated.

- **RASS 1 Remediated Area (Unit 8):** The marsh surface to the east of the central marsh and west of General Chemical property; this area was remediated to remove metals-contaminated soils.

- **Northern Lost Slough (Unit 9):** A natural tidal channel meandering through the Litigation Area marsh. The northern reach is closest to Suisun Bay and includes the mouth of the slough where it meets the bay.

- **Central Lost Slough (Unit 10):** The central reach of Lost Slough lies in a north-south orientation between the central and southeastern marsh; the portion of the slough is tidally connected to the RASS 3 pond through a small mosquito ditch.

- **Southwestern Reach of Lost Slough (Unit 11):** The smaller southwestern reach of Lost Slough runs westerly across Unit 4 and is a blind slough that narrows near its end on the western side of RASS 1.

- **RASS 2 Transitional Uplands (Unit 12):** This area consists of wetland and transitional upland between RASS 1 and the railroad berm; part of this unit includes the remediated area of RASS 2.

- **Nichols Creek and Pond (Unit 13):** Nichols Creek is a seasonal creek in RASS 3 that drains from the nearby hills and flows through the grassland habitat of Unit 13 into the RASS 3 pond, and eventually into Lost Slough. This area includes the remediated portion of RASS 3. Elevations range from approximately 27 feet above msl in the southeastern area to approximately 7 feet above msl on the edge of the pond in the northwestern area.

- **RASS 4 Upland (Unit 14):** RASS 4 is approximately 0.5 mile east of the other RASSs, and consists of upland habitat; part of Unit 14 includes the remediated area in RASS 4.

- **RASS 4 Wetland (Unit 15):** The emergent nontidal wetland in the eastern part of RASS 4 receives water from a drainage ditch from the surrounding upland habitat and housing development in the eastern part of RASS 4.

- **Upland Reference Area (Unit 16):** The upland reference area is bounded on the north by Port Chicago Highway and on the south by the Contra Costa Canal. This area is relatively far from, and upgradient of, the source of contamination and therefore probably represents regional ambient conditions related to deposition of chemicals from upland or other sources.

For the BERA, the assessment was focused on separate habitat areas that were considered appropriate exposure units for different types of receptors. These habitat areas roughly correspond to the spatial units described above and include:

- Marsh surface
- Marsh surface reference area
- Ditches
- Slough
- RASS 3 pond
- Nichols Creek
- RASS 4 wetland
- Uplands of RASS 3 and 4
- Upland reference area

5.9 DISTINCTION BETWEEN SOIL AND SEDIMENT

It is difficult to draw the distinction between sediment and soil in wetland and seasonal creek environments, since these areas are periodically inundated. For the monitoring program, the term "sediment" was applied to samples from the bottom of sloughs, ditches, and ponds that contain surface water every day of the year for most of the day. In addition, samples from Nichols Creek were also considered sediment, since water flows through the creekbed 9 months out of the year; the creekbed is dry during summer. The ditches may drain completely at low tide and may remain empty for as long as 3

hours, depending on how low the tide drops, but are typically inundated for most of the day. Most of Lost Slough is inundated continuously, except for the upper reaches furthest from Suisun Bay (Spatial Units 10 and 11) that drain completely for as long as 2 hours during exceptionally low tides (minus tides), which occur for a few days each month.

The term "soil" was applied to samples from upland areas (well above high tide elevation) and to the marsh surface, which is covered by surface water only during high tides. The duration of tidal inundation of the marsh surface was monitored during a surface water elevation study conducted from January 30 to June 16, 1996 (TtEMI 1999). Most of the marsh surface lies between 2.8 and 3.2 feet above msl, and the marsh surface in these areas is inundated by high tides from 10 to 25 percent of the time.

Soil is from locations that are not typically inundated for most of the day, whereas sediments are typically inundated most of the day. Information used to identify soil or sediment media includes:

- **Soil:** from any location with "SS" (SS = soil sample) in the location identification (marsh surface and upland habitat in RASS 3 and RASS 4, and the upland and marsh reference areas). Soil locations were all sampled using a randomly selected quadrat within the grid, so a different spot within the 100-by-100 foot grid was sampled each year.
- **Sediment:** from any location with "DH," "SH," or "WD" (DH = ditch, SH = slough, and WD = wetland) in the location identification (slough, ditch, RASS 3 pond, RASS 4 wetland, Nichols Creek, and proposed slough reference area). Sediment locations were all fixed sampling locations, so the same spot was sampled each year.

5.10 CHEMICALS OF POTENTIAL CONCERN

The RI identified six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as COCs at the site; additional evaluations of the full suite of inorganic and organic chemicals conducted during the QEA confirmed that these six metals were the primary risk drivers at the site (PRC 1997c). The monitoring program focused on the six metals of concern, with some additional sampling for mercury in RASS 4.

As agreed to with the regulatory and trustee agencies and as described in the work plan (TtEMI 2000d), all available data on inorganic and organic chemicals were evaluated for the screening-level HHRA. For the focused BERA, only the six metals were assessed. In addition, total DDTs and total PCBs/Aroclors were evaluated in a screening-level approach because of concerns about high detection limits (DL) achieved in the available data. In addition, for the BERA, new chemical data on other inorganic chemicals collected in October 2000 were screened to confirm that no other inorganic chemicals should be evaluated.

6.0 FIVE-YEAR REVIEW FINDINGS

The following sections present the findings of the five-year review assessment.

6.1 DOCUMENT REVIEWS, SITE INSPECTION, AND INTERVIEWS

Appendix A lists documents reviewed to provide information on site chronology and past decisions. A complete site history, including details on the remedial action decisions and implementation, is provided in Sections 3.0 and 4.0. Findings from the document review relevant to the assessment of protectiveness include the following:

- **Extent of Contamination:** The RI/FS focused on sites identified in the IAS. Sampling in RASS 1 was conducted for the RI on the eastern side near the sources; little characterization of the nature and extent of contamination in the western portion of RASS 1 or the main slough had been conducted at the time of remedy selection. Based on results of the QEA and monitoring program, significant concentrations of metals occur in soils, sediment, and surface water in the central and southwestern portion of RASS 1. Whether that contamination existed in those areas at the time of the RI or has since migrated to these areas is not known. As a result, the full extent of contamination may not have been known at the time the remedy was selected; however, extent of contamination has been characterized during postremediation monitoring.

- **Chemicals of Concern:** The nature and extent of contamination at the site has been well characterized by the monitoring program and the QEA sampling, which provided better spatial coverage and an evaluation of a full suite of inorganic and organic contaminants. The same six metals identified in the RI (arsenic, cadmium, copper, lead, selenium, and zinc) are still considered to be driving risk at the site based on results of the QEA (PRC 1997c) and the five-year review assessment.

- **Consistency with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP):** The Navy's remedial actions were selected and implemented in a manner consistent with the NCP. A consultative process, as well as the best available information at the time, was used. The Navy consulted with EPA, USFWS, RWQCB, and California Department of Health Services on the initiation, development, and selection of the RAP; these agencies did not object to the proposed RAP (Navy 1989a, 1989b). USFWS stated that the proposed plan was not likely to jeopardize the continued existence of the salt marsh harvest mouse or California Clapper Rail. The Navy received few written comments from regulatory and trustee agencies at the time the RAP/ROD was signed; some agency comments were received after the ROD was signed and before the remedy implementation. The Navy has worked closely with the regulatory and trustee agencies on the design and implementation of the monitoring program and other special studies to address agency concerns.

- **Remedial Action Objectives:** In the FS, the Navy established four specific objectives for remedial action, including (1) prevent biota from contacting contaminated soils that would threaten them, (2) prevent resuspension of contaminated sediments and soils in surface water and air and the redistribution of the contaminated sediments and soils which would threaten flora and fauna in the area, (3) minimize disturbance to the wetlands consistent with long-term protection of flora and fauna, and (4) prevent migration of contaminants into groundwater. At the Litigation Area, the remedy included active remediation of a portion of each RASS and passive remediation and monitoring of contaminants left in place in the remaining area of each RASS.

- **Selection of Cleanup Criteria:** The Navy selected TTLC, STLC, and SARAC values as cleanup criteria, as described in Section 3.3. While a biological assessment and a variety of bioaccumulation and toxicity tests were performed in the RI, cleanup criteria were not based on ecological risk numbers but were based on hazardous waste criteria. Metals concentrations at the site exceeding these hazardous waste criteria were correlated with observed biological effects, as reported in the RI and FS (Lee and others 1988a; Cullinane and others 1988). To protect wetland habitat and special status species, these criteria were waived and no cleanup was conducted in some contaminated portions of the wetland in RASSs 1 and 2. Contamination above cleanup criteria still persists in unremediated portions of RASS 1 and 2.

- **Triggers for Additional Actions**: The RAP/ROD clearly identified the potential for additional remedial actions in the passive remediation areas if warranted in the future, but did not define triggers or decision criteria for when that additional remediation would be required. Similarly, the monitoring program did not define criteria for additional actions or for the cessation of monitoring (exit criteria).

6.1.1 Site Inspection Tour and Subsequent Site Visits to Document Current Conditions

A site inspection tour was not required for the five-year review since the Navy has maintained an ongoing presence at the site while monitoring and other field activities were conducted; however, a site inspection tour was held on July 27, 2001, with the regulatory and trustee agencies. This site tour provided an opportunity to inspect general site conditions and ecology, access to the site, and results of remedial and restoration activities. A site inspection tour checklist, list of participants, and tour route map are included in Appendix B-1. Photographs from the site visit are included in Appendix B-2. In addition, the Navy hosted a site tour for RAB members on June 10, 2002. The important observations made and activities conducted during the site tour and subsequent site visits that are relevant to remedy protectiveness are summarized below.

- **Border of CPC and Nichols Creek.** The group observed (1) evidence of active soil erosion and surface water runoff in the northwestern corner of the CPC facility along the border of Nichols Creek. Evidence of standing water in the former surface impoundment area and sedimentation patterns on the paved surface indicated surface water runoff towards the creek; (2) the bank of Nichols Creek was eroded along parts of the CPC boundary; (3) a large stockpile of contaminated soil at CPC, derived from the excavation of the surface impoundment many years ago, is still present at the site and covered with plastic and tires. Large rips were noticed in the plastic covering the stockpile, indicating 15 to 20 percent of the contaminated soil was exposed to the elements.

- **Erosional Areas along Nichols Creek in RASS 3:** The group observed large erosional areas on railroad property along Nichols Creek, smaller areas of slumping of the creek bank on Navy property, and exposed soil beneath the culverts under the railroad tracks near the northwestern corner of CPC.

- **Railcar Spill between RASSs 2 and 3:** While walking along the SPTC railway between RASSs 2 and 3 on July 27, 2001, the group observed that a railcar on a railspur near General Chemical was leaking. A fine white powder was piling up under the car and was seen further along the tracks. Laurent Meillier (RWQCB) provided a more detailed report of the incident. This report is included in Appendix B-3. Mr. Meillier spoke with a General Chemical company spokesperson that indicated that the material was aluminum. RWQCB later analyzed a sample from the spill and found it contained 130,000 mg/kg of aluminum or 13-percent aluminum by mass. The sample also contained 1.1 mg/kg of beryllium and 41 mg/kg of zinc. RWQCB issued a 13267 letter to General Chemical subsequent to the site tour. At a site visit by TtEMI staff on September 5, 2001, additional rail cars were observed to be leaking. TtEMI staff also observed piles of white powder along the entire length of the railroad spur and in the adjacent wetlands leading into the General Chemical facility (see photographs in Appendix B-4).

- **RASS 1, Unit 11 Portion of Lost Slough:** The group crossed several mosquito ditches in the RASS 1 wetland to reach the Unit 11 portion of Lost Slough, where it passes under a fence. The group observed that water level was high in the slough, although not above the slough bank. The group discussed metals concentrations in sediments in this side arm of Lost Slough and how hydrology could create a “sink” for contamination in this area.

- **RASS 2 and Railroad Company Remediation Pits:** While walking along the ATSF railroad, the group observed that remediation efforts implemented by ATSF on railroad property in RASS 2 were not complete. Extensive soil removal had left large pits, the area has not been graded, and marsh vegetation has not been restored.

- **RASS 1 Active Remediation Area:** While walking along the edge of the active remediation and unremediated areas in RASS 1, the group observed several large patches of soft bird’s-beak (*Cordylanthus mollis* ssp. *mollis*) and that percent cover of pickleweed and other native plants was very high (almost 100 percent) in the remediated area of RASS 1, indicating the Navy’s restoration efforts were successful. The group also observed sediment accretion had occurred in the mosquito ditches as evidenced by shallow depths in the distal ends of ditches).

- **Area of Distressed Vegetation along Berm between General Chemical/Honeywell, Inc. Facilities and Navy Property (RASS 1):** The group crossed the remediated area of RASS 1 and climbed the earthen berm separating Navy property and General Chemical/Allied Signal/Honeywell properties. Phillip Ramsey, EPA, noted the stark difference between the Navy's restored wetland and the barren lagoons on the chemical companies' property. In addition, the group noted that General Chemical is under voluntary compliance and is currently conducting a HHRA and an ERA. Arsenic, zinc, aluminum, and pH are just some of the COCs at the neighboring property.

  Mr. Ramsey (EPA) and Mary Gleason (TtEMI) noted an area of distressed and dead vegetation at the base of the berm on the Navy's property. This vegetation was in an actively remediated area between the berm and groundwater monitoring well 1AGO3 that formerly contained healthy vegetation (Appendix B-1). They observed bright orange pickleweed and black soil in this area. Dead and distressed vegetation was present immediately adjacent to the berm, including part of the berm slope, and was surrounded by healthy vegetation. On a subsequent visit in September 2001, TtEMI staff took additional photographs of the area of distressed vegetation (Appendix B-4). In November 2001, TtEMI staff mapped the area of distressed vegetation, which was approximately 160 feet long and varied from 8 to 40 feet wide (Appendix B-5).

- **RASS 4 Access Concerns:** The group entered RASS 4 through an unlocked gate along Port Chicago Highway. The group walked west through coyote brush and found motorcycle tracks through the middle of RASS 4, indicating the presence of trespassers and failure of access controls. At the west end of the tracks, another gate to Port Chicago Highway had been broken open, allowing access to trespassers. Bare, compacted soils were noted along the motorcycle tracks in the actively remediated area of RASS 4. At the eastern end of the motorcycle tracks in RASS 4, evidence was present of motorcycles being driven in the wetland area. Rudy Pontemayor, the facility environmental coordinator, immediately alerted base security, and the locks were replaced and gates were secured that afternoon.

- **RASS 4 Semilithified Soils:** During the July 27, 2001, site tour, the group observed semilithified or ashy soil along the motorcycle tracks in RASS 4. The group could not characterize the soil through visual observation. Historic aerial photographs were reviewed to verify that areas where wastes may have been dumped in the past had already been sampled. This review indicated previous coke piles or dumping areas had been sampled. It could not be determined whether the area of semilithified soil had been sampled in the past, so characterization of this soil was determined to be a data gap.

- **RASS 4 Fire:** TtEMI visited the site on the September 5, 2001, and observed that approximately one-third of RASS 4 had burned in a fire. The fire burned coyote brush that had been planted in the remediated area and introduced grasses that had colonized the area since the remediation. On a return visit in February 2002, TtEMI staff observed that coyote brush was resprouting in the area that had burned.

6.1.2 Interviews

No interviews were held since no outstanding questions were identified at the time the draft final report was completed.

6.2 CHANGES IN APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS, GUIDANCE, AND TO BE CONSIDEREDS

The Navy issued its ROD on April 6, 1989, selecting the final RAP for the Litigation Area. Pursuant to Section 121(d)(2) of CERCLA, the Navy's remedial action was required to attain legally ARARs at the completion of the remedial action. During the 5-year review, the NCP directs that levels or standards of control used in the remedial action will not be reopened unless new or modified requirements call into question the protectiveness of the remedy. This policy is also known as EPA's policy of "freezing" ARARs when the ROD is signed. The following chemical- and location-specific requirements, identified and adopted in the RAP, were reviewed for changes that could affect protectiveness:

- RCRA, as operated by the State of California (22 *California Code of Regulations* [CCR] Division 4.5, Section 66000 *et seq.*): hazardous waste management
- Sections 402 of the Clean Water Act (CWA): protection of surface water quality
- Sections 7 and 9 of the Endangered Species Act: protection of endangered species
- Sections 2080 and 5650(f) of the California Fish and Game Code: protection of endangered species, fish, plant life, and bird life
- Section 404 of the Clean Water Act, Executive Order 11,990 (Wetlands Protection), and Section 13376 of the California Water Code: protection of wetlands
- Executive Order 11,988 (Floodplain Management): protection of floodplains

The above requirements were identified as applicable or relevant and appropriate for all four RASSs at the Litigation Area. Of particular importance to this review of the protectiveness of the remedy were RCRA TTLC and STLC criteria for arsenic, cadmium, copper, lead, selenium, and zinc promulgated under Title 22, Division 4.5 of the CCR to implement RCRA in California.[1] These criteria were identified by the Navy as criteria for developing remediation goals to actively remediate heavily contaminated soils in each RASS. In areas of RASS 1 and RASS 2 where active remediation to TTLC and STLC criteria would have resulted in substantial destruction of 8.21 acres of critical wetland habitat, the Navy waived attainment of these RCRA standards pursuant to Section 121(d)(4)(B) of CERCLA. Waiver of these requirements also promoted attainment of state and federal ARARs relating to protection

[1] TTLC/STLC criteria under Title 22 are promulgated under Chapter 6.5 of Division 20 of the California Health and Safety Code (§§ 25100-25250.25), entitled "Hazardous Waste Control." A substantial body of these regulations were rewritten and recodified in 1991, following adoption of the ROD and RAP, to conform more closely to RCRA. Since recodification, EPA authorized the Toxic Substances Control Program of the DHS (renamed the Department of Toxic Substances Control in 1991) to administer RCRA in California in lieu of the federal program. As noted above, TTLC/STLC criteria did not change upon recodification, although then, as now, TTLC/STLC criteria were considered more stringent than comparable standards for identifying hazardous waste under 40 C.F.R. Part 261 of federal RCRA.

of wetlands and endangered species by limiting destruction of a sensitive ecosystem. TTLC and STLC criteria have not changed since the remedy was chosen.

Though EPA and the California regulatory agencies did not object to the ROD and RAP during preselection consultation or the public comment period on the proposed remedy, EPA did raise concerns in 1993 that use of STLC and TTLC criteria would not provide adequate environmental protection and that an ERA should be used to define cleanup criteria. The Navy responded that the remedy was selected consistently with the NCP (including substantial agency and peer review) and EPA preliminary guidance available at the time. Rather than reopen the decision after over 10 years of investigation and remedial design, the Navy proceeded with the remedial action based on these ARARs and agreed to conduct a QEA to assess risk from contaminants remaining on site. Implementation of the selected remedy was consistent with Congressional policy to expeditiously cleanup sites and EPA policy to reduce risk and avoid interruption, reevaluation, and redesign of selected remedies (see NCP preamble at 55 Federal Register 8757-8756 [1990]). In areas of active remediation, the Navy excavated all metals-contaminated soils exceeding TTLC and STLC criteria before backfilling, grading, and revegetating disturbed areas. The Navy met these cleanup criteria in areas where they were not waived.

The Navy acknowledges that current guidelines support the use of risk assessment to help make decisions on protectiveness and cleanup goals for ecological and human receptors. Considering the refinement of risk assessment methodology and guidance since selection of the remedy in 1989, the Navy believes that RCRA TTLC and STLC criteria are no longer appropriate for assessing protectiveness or developing remediation goals. As a result, a screening level HHRA (Appendix F) and a BERA (Appendix G) were included in this five-year review to evaluate whether areas actively remediated to TTLC and STLC levels and areas with contaminants left in place still pose an unacceptable risk to human or ecological receptors. Accordingly, the Navy is adopting the following TBC information in lieu of RCRA:

- EPA. 1989. "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation (Part A), Interim Final." EPA Office of Emergency and Remedial Response. EPA/540/1-89/002. December.

- DTSC. 1992. "Supplemental Guidelines for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities." Office of the Science Advisor. Sacramento, California. July.

- EPA. 1997a. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments." Interim Final. EPA540-R-97-006. Washington, DC.

- EPA. 1998. "Guidelines for Ecological Risk Assessment." EPA/630/R-95/002F. Washington, DC.

- EFA West. 1998. "Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California." Interim Final. Technical Memorandum. CTO027, contract number N62474-94-D-7609. September.

These guidelines were used to conduct the HHRA and BERA to support the five-year review assessment and provide information for evaluating protectiveness of the remedy and the need for additional actions.

In addition, the Navy identified new CWA standards as relevant to protectiveness of the remedy. The Navy identified Section 402 of the CWA in the RAP as a chemical-specific requirement for each RASS. Section 402 provides authority to EPA or an approved state program to issue permits for the discharge of pollutants into waters of the United States. While the remedy was designed to prevent the discharge of pollutants during the remedial action, the RAP failed to identify substantive requirements of the CWA to protect human health and the environment. Since postremediation monitoring detected levels of metals above AWQC in surface waters of the site, the Navy identified the following standard, recently promulgated under the CWA, as bearing on protectiveness: Water Quality Criteria for priority toxic pollutants, codified at Title 40 *Code of Federal Regulations* Section 131.38 (2000) (also known as the California Toxics Rule [CTR]).

Under Section 303(c)(2)(B) of the CWA, Title 33 *United States Code* Section 1313(c)(2)(B), states are required to adopt numeric criteria for priority pollutants that may impair the beneficial uses of water bodies within their borders. On May 18, 2000, EPA promulgated the CTR to fill a gap in California's Section 303 water quality standards created when a state court overturned California's water quality control plans that contained water quality criteria for priority pollutants. CTR criteria set levels for acute and chronic exposure to dissolved metals contamination found to be protective of aquatic life. In combination with beneficial use designations in RWQCB's Bay Basin Plan (RWQCB 1995) for the San Francisco Bay Basin, these criteria are applicable water quality standards for ambient surface water in the Litigation Area. After consultation with EPA and RWQCB, the Navy identified numeric criteria presented in Tables 10A and 10B as the applicable ARARs for surface water quality in the ditches and sloughs, these values include the lower of the freshwater or saltwater criteria from EPA (National Toxics Rule and California Toxics Rule) and, for mercury, the criterion from RWQCB's Bay Basin Plan. The Navy compared all surface water chemistry data with these water quality criteria in its evaluation of the protectiveness of the remedy; while not all of these screening values are AWQC, the general term AWQC will be used for convenience for the surface water screening values for the Litigation Area.

In addition, there was a change in location-specific ARARs, the federal and California Endangered Species Acts. Three animal species with special status were considered during selection and implementation of the remedy: salt marsh harvest mouse, California Clapper Rail, and California Least Tern. Based on numerous site-specific wildlife surveys, the Clapper Rail and the Least Tern are not considered by the Navy to inhabit the site. A complete list of all special status species occurring or potentially occurring at the Litigation Area is provided in Table 11. Table 12 provides a shorter list of species protected under the federal or state Endangered Species Acts. Since other threatened or endangered species have been observed at the site or have been given special status since 1989, the protectiveness of the remedy was evaluated in light of this new information.

The Navy has reviewed other chemical-, location-, and action-specific ARARs identified in the RAP and has identified no further changes to these requirements that may affect the protectiveness of the remedy. The Navy included the passive remediation and monitoring components of the remedy in its five-year review. However, since the RAP did not include federal or state standards related to passive remediation and monitoring, there were no standards to evaluate for these components. The protectiveness of the passive remediation and monitoring components of the remedy are discussed in the following sections (and in more detail in Appendices D, E, F, and G).

The Navy is evaluating whether the new Small Business Liability Relief and Brownfields Revitalization Act (42 U.S.C. Section 9607[q]), signed by the President on January 11, 2002, affects the Navy's liability for contamination from off-site contiguous properties.

6.3 SUMMARY AND EVALUATION OF THE MONITORING PROGRAM

The Navy has completed the preremediation, during remediation, and 5 years of postremediation monitoring, as described in Section 4.0. Appendix D summarizes the results of the monitoring program, including preremediation monitoring conducted in 1991 (PRC 1994a) and the 5 years of postremediation monitoring conducted from 1995 through 1999 (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a). Appendix D also provides an evaluation of the effectiveness of the monitoring program. This section provides a summary of Appendix D.

The monitoring objectives were slightly revised in year 2 (PRC 1997a), as described in Section 4.0; revised postremediation monitoring objectives are presented below:

- **Objective 1:** Collect data that will assist in evaluating long-term changes in site conditions
- **Objective 2:** Evaluate potential contaminant migration to Suisun Bay (groundwater, surface water, and sediment)
- **Objective 3:** Determine if the active remediation areas become recontaminated; if so, determine the extent of recontamination and potential sources
- **Objective 4:** Evaluate contaminant migration in the unremediated areas
- **Objective 5:** Monitor the overall habitat quality of the site, including the success of the restoration and use of the site by special status plants and animals
- **Objective 6:** Determine if the groundwater is impacted by the contamination.

The monitoring program involved (1) chemical sampling of soil, sediment, and surface water analyzed for the six metals identified as COCs in the RI (Lee and others 1986): arsenic, cadmium, copper, lead, selenium, and zinc; (2) conducting ecological surveys; and (3) conducting other special studies. Some level of monitoring was conducted in each of the four RASSs and the reference areas. The same upland reference area was used for preremediation and postremediation monitoring (Figure 2). The preremediation shoreline reference area (located west of the Litigation Area) was replaced in the postremediation monitoring by the marsh reference area established in the northwestern corner of RASS 1 (Figure 2). The monitoring program design was also revised between the preremediation and postremediation periods to better address concerns at the site, as described in Section 4.0. This redesign addressed concerns about the monitoring program but limited the comparison of some types of preremediation and postremediation data.

6.3.1 Preremediation Monitoring Program

The preremediation monitoring program outlined in the WES monitoring plan (Lee and others 1989a) was conducted during 1991, and results of the program were reported in the baseline conditions report (PRC 1994a). Each RASS was divided into active remediation, passive remediation, and monitoring areas. A map of the RASSs was overlaid with a 100-foot grid system to facilitate consistent location of the samples. Most sampling locations (approximately 75 percent) were concentrated along the boundaries between the active remediation areas, passive remediation areas, and monitoring areas (Figure 11). Approximately 25 percent of the chemical sampling locations were randomly placed throughout the active, passive, and monitoring areas.

Surface soil and sediment samples were collected from 0 to 0.5 foot bgs; at a subset of locations, subsurface soil samples were collected from 0.5 to 1.0 and 1.0 to 1.5 feet bgs. Three replicate samples

were collected at the same time at each soil and sediment sampling location to evaluate sample variability. Filtered and unfiltered surface water samples were collected at each sediment sampling location; three rounds of surface water sampling were conducted at each location, with approximately 16 days between the rounds.

Preremediation ecological monitoring included vegetation, small mammal, and rail surveys. Plant community mapping and special status plant surveys were conducted throughout the Litigation Area. Vegetation characterization and small mammal surveys were conducted at 85 soil sampling locations. These locations are circled in red on Figure 11. For the small mammal surveys, several individual trapping sites were randomly located within a 100-by-100-foot grid at each location. The rail surveys were conducted along transects established in each of the four RASSs.

6.3.2 Postremediation Monitoring Program

The postremediation monitoring program also included both chemical and ecological monitoring; however, changes to the design of the program were made based on results of data collected before and during remediation and discussions with the regulatory and trustee agencies. Concerns that prompted the redesign included (1) the biased nature of the sampling design, (2) the lack of samples in sloughs or ditches and other parts of the site, (3) the high variability of the existing chemistry data and the feasibility of assessing changes using the original design, and (4) the artificial distinction between the monitoring and passive areas since both were contaminated. The Navy added many more sampling locations across the site, including in the sloughs and ditches, where few samples had been collected. The design was also changed to include randomly selected sampling locations, where possible, and single, rather than triplicate, samples at each location. The same 100-foot-by–100-foot grid was used to randomly select postremediation sampling locations. The approach allowed for better characterization of contaminant levels at a broader spatial scale across the site. Postremediation monitoring results were presented in a series of annual reports (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a).

Rather than dividing the site into active, passive, and monitoring areas, the four RASSs were divided into 16 spatial units based on physical boundaries, concentrations of metals, and types of habitat (Figure 12). The purpose of these spatial units was to provide a means to identify spatial changes in contaminant concentrations over time in soil, sediment, and surface water. Appropriate sample sizes required to detect significant changes in concentrations for each spatial unit were determined using statistical power analyses.

Postremediation chemical monitoring included the same six metals of concern; mercury analysis was added for RASS 4 samples because the QEA (PRC 1997c) found mercury in RASS 4 to be a potential risk to ecological receptors. Soil and sediment samples were also analyzed for pH, conductivity, interstitial salinity, TOC, and grain size. Surface soil samples (0 to 0.5 foot bgs) from marsh surface or upland locations were collected within the sample grid at a different randomly selected quadrat each year. Sediment samples collected from sloughs, ditches, and ponds were all fixed sampling locations that did not vary from year to year. Unfiltered surface water samples were collected at each sediment sampling location and analyzed for total concentrations of the six metals; surface water was also analyzed in the field for pH, conductivity, temperature, turbidity, salinity, and dissolved oxygen content. A subset of filtered surface water samples was collected in year 4 and year 5 and analyzed for dissolved metals.

Postremediation ecological monitoring also included vegetation, small mammal, and rail surveys, as well as monitoring of revegetation success in areas disturbed by remedial actions. Like preremediation monitoring, vegetation surveys included vegetation characterization, plant community mapping, and a special status plant survey. The plant community mapping and special status plant survey were conducted throughout the Litigation Area. Small mammal trapping and vegetation characterization was conducted along trapping transects and trapping grids established in each RASS, rather than at individual soil sampling locations, as was done in the preremediation monitoring. The rail surveys were conducted on the same transects established for preremediation monitoring in each RASSs. Postremediation ecological survey transects and grids are shown on Figure 21.

6.3.3 Chemical Sampling Results

Metals concentrations were monitored in sediment, soil, and surface water throughout the Litigation Area to address three main topics related to the monitoring objectives:

- Spatial and temporal patterns in chemical concentrations across the site
- Recontamination of remediated areas
- Migration of contaminants across the site, especially in Nichols Creek, mosquito ditches, and the tidal slough (Lost Slough) that connects to Suisun Bay

Graphical and statistical evaluations of metals concentrations and focused studies on metals migration were used to address these issues. Soil and sediment concentrations were compared with NOAA's ER-L and effects-range median (ER-M) benchmarks. For selenium, RWQCB's WCC for cover (WCC-c) and for noncover (WCC-nc) soil were used (RWQCB 1992), because no effects-range values are available for

selenium. Surface water concentrations were compared with AWQC or basin plan objectives presented in Tables 10A and 10B.

6.3.3.1 Soil and Sediment Sampling Results

Average preremediation soil and sediment concentrations tend to be higher than the five-year postremediation averages (Tables 17 and 18). However, differences in design between preremediation and postremediation monitoring limit any conclusions based on these differences. The annual postremediation monitoring provides a more accurate evaluation of temporal changes.

Concentrations of metals in soil and sediment on the scale of the spatial unit have undergone little change over the 5 years of postremediation monitoring. Spatial units with significant metals contamination have remained contaminated; remediated areas, reference areas, and areas further from the historical spills consistently showed low metals concentrations. Considerable variability existed on the scale of the sampling location; lateral and vertical distributions of metals varied on the scale of the sampling grid.

In addition to the marsh reference area and the upland reference area (Units 1 and 16), the northern marsh (Units 2 and 3) and the northern reach of Lost Slough (Unit 9) remain relatively uncontaminated. In 500 individual metal sample results for arsenic, cadmium, copper, lead, and zinc collected from Units 2 and 3 over a 5-year period, the ER-M was exceeded in only 35 instances (7 percent of sample results). In Unit 9, 26 of 445 individual metal results exceeded the ER-M for those five metals (6 percent of sample results). The mean concentrations have been remarkably similar over 5 years of monitoring in Units 2, 3, and 9, with a similar number of results exceeding benchmark values. The RASS 4 wetland (Unit 15) is also relatively uncontaminated. Except for some elevated selenium concentrations, metals concentrations were consistently below benchmark values.

The central marsh (Units 6 and 7), west of the RASS 1 remediated area, still has some of the highest concentrations of metals in the Litigation Area, because of its proximity to a former contamination source in the General Chemical waste ponds. Mean metal concentrations and the number of results exceeding benchmark values in Units 6 and 7 have been relatively consistent over 5 years of monitoring; these results indicate that no significant migration of metals into, or out of, these units occurred.

Zinc is the primary metal of concern in sediment from Nichols Creek (Unit 13) and the contaminated portion of Lost Slough (Units 10, and 11). Special attention has been focused on metals in Nichols Creek and Lost Slough because of the high potential for transport of metals from these areas into Suisun Bay. There is a strong spatial gradient for zinc concentrations in sediments of Lost Slough (Units 9, 10, and

11), with highest concentrations nearest the historic upland source (CPC) adjacent to RASS 3, in the RASS 3 wetland, and in the southwestern portion of Lost Slough (Unit 11). Forty-eight of 51 sediment samples collected from Unit 11 over 5 years of monitoring have exceeded the ER-M for zinc; however, the zinc cleanup goal for RASS 3 (SARAC of 2,512 ppm) was also significantly higher than the ER-M. The mean concentration of zinc in Unit 11 has varied; however, zinc has been consistently detected above four times the ER-M, with the highest mean concentration of 13,140 mg/kg in year 3. Concentrations of metals in Nichols Creek are significantly higher at locations just below CPC, rather than above the facility; however, concentrations in these areas have not changed significantly over time. Seventy-two percent of the 162 sediment samples collected during 5 years of monitoring in Unit 13 has exceeded the ER-M for zinc. The RASS 3 wetland, which should act as a sink for metals, has not shown significant increases in concentrations over the 5 years of monitoring despite visual observations that suggest soil along Nichols Creek may be eroding in some areas.

Metal concentrations in the remediated areas (Units 8, 12, 13, and 14) have remained consistently low, with no significant upward trends. The statistical evaluation indicates that remediated areas are not being recontaminated from neighboring sources and metals concentrations are consistent over time.

6.3.3.2 Surface Water Sampling Results

Average preremediation surface water concentrations tended to be higher than the five-year postremediation averages (Table 19). In both the northern and central marsh ditch units (Unit 3 and 7), all of the postremediation average total metals concentrations were lower. In the central reach of Lost Slough (Unit 10), total concentrations of arsenic, copper, lead, and zinc were higher during postremediation monitoring. A similar result occurred for Nichols Creek and pond (Unit 13), where copper, lead, and zinc were higher during postremediation monitoring. In the RASS 4 wetland (Unit 15), all of the postremediation total metals concentrations were lower, although not as dramatically as in the ditch units.

A pattern of higher average postremediation total metals concentrations in the Unit 10 slough and Nichols Creek and pond (Unit 13) suggests that on- or off-site sources of metals to surface water pathways may be continuing.

As shown in Table 19, average dissolved metals concentrations are significantly lower than average total concentrations, indicating the a large proportion of surface water metal concentrations are a result of suspended solids in the water. The pattern for preremediation versus postremediation dissolved metals concentrations was similar to the total metals concentrations, indicating a general decrease following

remediation activities, particularly in Units 3, 7, and 15. However, in Units 10 and 13, the higher postremediation total concentrations for arsenic, copper, lead, and zinc are not typically reflected in the dissolved concentrations, suggesting that if metals migration is occurring in these units, it is likely in the form of suspended sediments.

Evaluation of postremediation surface water results indicates that concentrations of metals in surface water from the mosquito ditches are generally higher than concentrations in water from Lost Slough. Surface water samples from the ditches in the southern portion of RASS 1 (Units 5 and 7) had concentrations of all six metals above AWQCs; however, arsenic, copper, and zinc were detected at concentrations exceeding AWQC more frequently than cadmium, lead, or selenium. Surface water samples from Units 10 and 11 also had concentrations greater than AWQCs for copper and zinc; concentrations were much lower in Unit 9 near Suisun Bay and a few concentrations were detected exceeding water quality criteria. Nichols Creek and RASS 3 wetland exhibited variable water sampling results. Copper and zinc concentrations exceeded benchmark values at numerous locations. High detection limits achieved by the analytical laboratory that were above AWQC, particularly for copper, limit the interpretation of nondetect data.

6.3.4 Ecological Monitoring

Ecological surveys conducted at the Litigation Area document that this area provides important habitat that supports many special status plants and animals. Overall, vegetation diversity and habitat quality are high in the wetland portions of this site, and numerous special status plants and animals are consistently present in the RASS 1 marsh. The upland portions of the site can be characterized as disturbed habitat dominated by introduced plant species; however, these areas are also used by numerous species of birds and mammals.

6.3.4.1 Special-Status Plant Species Surveys

Baseline vegetation surveys, including mapping special status plants, were conducted prior to remediation and then annually in Years 1 through 5 as part of the postremediation monitoring effort. The following special status plant species have been observed at the site during either preremediation or postremediation monitoring:

- Soft bird's beak (*Cordylanthus mollis* ssp. *mollis* [Federal Endangered; California Native Plant Society (CNPS) List 1B; California Rare])
- Mason's lilaeopsis (*Lilaeopsis masonii* [Federal Species of Concern; CNPS List 1B; California Rare])
- Delta tule pea (*Lathyrus jepsonii* var. *jepsonii* [Federal Species of Concern; CNPS List 1B; No State Listing])
- Suisun Marsh aster (*Aster chilensis* var. *lentus* [Federal Species of Concern; CNPS List 1B; No State Listing]).

In year 5 of the postremediation monitoring, the marsh gumplant (*Grindelia stricta* var. *augustifolia*) (No Federal Listing; CNPS List 4; No State Listing) was also observed.

During preremediation surveys, Delta tule pea, soft bird's beak, and Mason's lilaeopsis populations were located in the Litigation Area, but Suisan Marsh aster was not found. During postremediation monitoring, soft bird's beak, Mason's lilaeopsis, delta tule pea, and Suisun Marsh aster were all identified within portions of RASS 1, RASS 3, or the marsh reference area. None of the other RASS or reference areas was found to support these or any other special status plants. Although special status species show considerable population fluctuation throughout the postremediation monitoring, the numbers of populations have generally increased for most species.

Soft bird's beak has been present in RASS 1 since the 1991 preremediation surveys. However, the number of aggregations (cluster of individual plants found at a single location) of soft bird's beak has generally increased in the Litigation Area over the past 5 years of postremediation monitoring. Mason's lilaeopsis is not abundant at the Litigation Area; the 1991 preremediation surveys found two aggregations, while later surveys found two additional aggregations. The delta tule pea was not observed during preremediation survey, but has since been found; the number of aggregations for this species peaked in year 5. Suisun Marsh aster was not found during the 1991 preremediation surveys; however, during the 5 years of postremediation monitoring, the number of individuals of Suisun Marsh aster observed has increased. Marsh gumplant was added to the Litigation Area special status plant survey in year 5 and was found to be very common along ditches and other densely vegetated portions of RASS 1.

6.3.4.2 Success of Revegetation Efforts

The remediated portions of each RASS were revegetated between 1994 and 1996, and postremediation revegetation monitoring was conducted during years 1 through 5. Revegetation success criteria and monitoring parameters for each of the revegetation areas were described in the revegetation plans

(H.T. Harvey and Associates 1989, 1995). The four plant associations established within the RASS 1 revegetation area were pickleweed marsh, lower transition marsh, emergent marsh, and upland refugial mound. The three plant associations established within the RASS 2 revegetation area were pickleweed marsh, alkaline upper marsh, and upper marsh. Coyote brush was planted in the RASSs 1 and 2 staging area. RASS 3 was not revegetated but was reseeded. The plant associations in RASS 4 included freshwater and brackish wetland and coyote brush plantings.

The revegetation success criteria and the degree to which the criteria were met by the fifth year of monitoring are presented below:

Remedial Action Subsite (RASS)	Revegetation Areas	5-Year Success Criteria	Revegetation Success Achieved by Year 5 Monitoring Period
RASS 1	9-acre tidal marsh revegetation area	80 percent native plant cover	Pickleweed marsh: 81.3 percent native cover Lower transition marsh: 83.2 percent native cover Emergent marsh: 100.0 percent native cover Upland refugial mounds: 30 percent native cover
RASS 2	4-acre tidal marsh revegetation area	80 percent native plant cover	Pickleweed marsh: 70.3 percent native cover Alkaline upper marsh: 78.8 percent native cover Upper marsh: 25.1 percent native cover
RASSs 1 and 2 (Staging Area)	1.4-acre coyote brush planting area	50 percent coyote brush survival	Coyote brush: 85.0 percent survival
RASS 3	6.9-acre wetland and upland natural revegetation area	No criteria set	Not applicable
RASS 4	2.5-acre emergent marsh and coyote bush revegetation area	60 percent native plant cover and 60 percent coyote brush survival	Wetland revegetation: 99.4 percent native cover Coyote brush: 55 percent survival

Table 20 summarizes the progress achieved toward revegetation success by the end of each monitoring year and identifies areas where revegetation efforts were not completely successful. Within RASS 1, pickleweed marsh, the lower transitional marsh, and the emergent marsh habitat associations have met the final year 5 success criterion of 80 percent native plant species cover; the refugial mound habitat associations had not met the success criterion because of the presence of nonnative grass species such as Mediterranean barley, perennial ryegrass, and annual rabbitfoot grass (*Polypogon monspeliensis*). None of the habitat associations in RASS 2 had met the final year 5 success criterion of 80 percent native species cover; it is likely that the elevation and consequent hydrology of this area does not promote the establishment of salt marsh habitat. The RASS 3 revegetation area is progressing and maturing favorably; various emergent wetland plants have colonized the RASS 3 pond, while the drier eastern portion of the remediation area is dominated by nonnative grasses. The RASS 4 wetland revegetation area has

consistently exceeded the 60 percent final success criterion for years 1 through 5. The upland revegetation area of RASS 4 has not met the final success criterion of 60 percent survival of coyote brush, although by year 5 survival rate was 55 percent. Coyote bushes were planted in subsoil after the contaminated topsoil was removed, and reduced topsoil amounts and competition with weedy species may have contributed to the high mortality of coyote bush at this site. In August 2001, a fire in RASS 4 burned a significant portion of planted coyote brush and nonnative grasses and thistles. By February 2002, many of the coyote bushes had begun to resprout. Coyote brush planted within RASSs 1 and 2 staging area have met the 50 percent success criterion.

While not all areas have met all success criteria for revegetation, the Navy believes that satisfactory progress has been made toward restoration goals and that further revegetation efforts are not warranted at this time.

6.3.4.3 Small Mammal Surveys

Small mammal trapping surveys were conducted in 1991 and from 1995 to 1999 (years 1 through 5) as part of the post remediation monitoring effort. All surveys placed emphasis on monitoring for the presence of the salt marsh harvest mouse, an endangered species known to inhabit the saline emergent wetlands of the Litigation Area.

Small mammal surveys were conducted in all four RASSs and reference areas. In 1991, mammals were trapped at individual sampling locations; during postremediation monitoring, standard transect and grid sampling was performed across the site. Small mammal surveys used the trap and release method. All captures were fur clipped to distinguish recaptures and were identified by species, sex, and age. All salt marsh harvest mice were identified using Shellhammer's methodology (1984). Vegetation was characterized at each survey trap location, including a visual estimate of percent cover for each species, as well as bare ground, thatch and litter. Small mammals trapped at the site included the salt marsh harvest mouse, the western harvest mouse (*Reithrodontomys megalotis*), unidentified harvest mice, California vole (*Microtus californicus*), the house mouse (*Mus musculus*), the deer mouse (*Peromyscus maniculatus*), and the Norway rat (*Rattus norvegicus*).

In 1991, relatively large numbers of salt marsh harvest mice were captured in RASS 1 and the shoreline reference area. Salt marsh harvest mouse captures were generally highest in areas with relatively high-percent cover values of pickleweed. However, it was also trapped in areas with relatively high cover values for saltgrass, peppergrass (*Lepidium latifolium*), and Baltic rush (*Juncus balticus*).

The number of salt marsh harvest mice and other small mammals captured has varied greatly over the 5 years of postremediation monitoring, as is typical of small mammal populations. In year 5 of the post remediation monitoring, the total number of small mammals, and the number of salt marsh harvest mice, were greater than any previous survey year for the postremediation monitoring period.

Vegetation associations for salt marsh harvest mice are similar to preremediation findings; the preferred vegetation is pickleweed, saltgrass, and Baltic rush. Salt marsh harvest mice are actively recolonizing the pickleweed habitat in the remediated areas of RASSs 1 and 2. Salt marsh harvest mice captures were higher than for western harvest mice in trapping grids in remediated areas in years 2 through 5.

6.3.4.4 Black Rail Surveys

Baseline surveys were conducted in 1991 for the California Black Rail and California Clapper Rail; postremediation surveys were conducted along the same transects but clapper rail surveys were discontinued in year 4 because few individuals had been detected. Clapper rails at the site are believed to represent transitory, unmated males moving through the area and not members of any resident population at the site, since the appropriate habitat for this species is not present.

The California Black Rail was listed as a State Threatened Species in 1971 by CDFG, and is also a Federal Candidate Species, Category 1, for listing as Threatened or Endangered by USFWS [1991]).

California Black Rail surveys were conducted on transects in the tidal marsh of RASS 1 and RASS 2. Black rail “kik-kik-kerr” and “gurrr” calls (recorded at Naval Weapons Station SBD Concord in 1985) were broadcast through a stereo-amplified speaker system from census stations. In postremediation surveys, the density of black rail populations was calculated; only male calls were used for population estimates, because past research has shown that male detections are more consistent than female detections (Legare 1996). California Black Rails are apparently monogamous, and past research has shown a 1:1 sex ratio (Flores and Eddleman 1993; Eddleman and others 1994). Therefore, estimates of population densities were determined by doubling the value obtained for male abundance.

A statistically significant increase in rail numbers occurred during the 5 years following remediation. The best estimate of black rails at the Litigation Area in the year 5 monitoring event was 120 birds (60 males), higher than previous estimates of 66, 64, 68, and 96 birds for year 1 through year 4, respectively. The year 5 estimate also represents a 6-fold increase in the number of black rails since the 1991 preremediation survey, when approximately 17 birds were estimated to reside in the marsh. Black rail

densities have increased from 0.407, 0.397, 0.414, 0.589, and 0.738 male rails per hectare for years 1 through 5, respectively.

The black rail population increase was probably related to the increased number of rails adjacent to, and within, the RASS 1 remediated area in year 5, and a dramatic increase in rail numbers in the southern portion of the tidal marsh. The increase in black rail densities is likely a reflection of increased suitable vegetation such as cattails and bulrush. No association is apparent between locations where black rails were detected and mosquito ditches, indicating that black rails are not likely to depend on this habitat feature.

6.3.5 Evaluation of Effectiveness of the Monitoring Program

The success of the monitoring program at meeting objectives and the use of long-term monitoring as part of the remedy for monitoring contaminants left in place were evaluated for the five-year review.

6.3.5.1 Evaluation of Success at Meeting Monitoring Objectives

The monitoring objectives set forth in the WES monitoring plan (Lee and others 1989a) and the subsequent revised versions were very general and contained no specific criteria to trigger additional monitoring or further remedial actions. Although the monitoring program has not addressed every issue of concern at the site, data collected during the five-year monitoring program have been sufficient to fulfill the monitoring objectives. In addition to fulfilling the monitoring objectives, the five-year monitoring program has provided data that will focus future efforts at the site, whether those efforts are additional remediation or future monitoring. Success at meeting monitoring objectives is described below:

- **Objective 1 (collect data that will assist in evaluating long-term changes in site conditions):** This objective was accomplished by collecting chemical and ecological data in a consistent manner over a 5-year period. Statistical power analyses were used to determine the appropriate number of samples from each spatial unit to allow detection of concentration changes within, or between, units with a quantifiable level of certainty. Both statistical and graphical evaluations were used to identify changes or trends in concentrations at the scale of the spatial unit. Ecological surveys were conducted annually in a consistent manner to evaluate use of the site by special status species and to monitor the success of restoration efforts.

- **Objective 2 (evaluate potential contaminant migration to Suisun Bay):** This objective was accomplished by collecting soil, sediment, and surface water samples in contact with Suisun Bay through a network of ditches and sloughs in a consistent manner over a 5-year period and by conducting special studies to evaluate potential migration during storm events and the net flux of dissolved metals and suspended sediment during incoming and outgoing tides. These studies showed little migration of contaminants to the Bay, but did indicate potential uncontrolled migration within ditches and sloughs in southern RASS 1.

- **Objective 3 (determine if the remediated areas become recontaminated, and if so, the extent of recontamination and potential sources):** This objective was accomplished by collecting soil, sediment, and surface water samples in remediated areas in a consistent manner over a 5-year period. These data were statistically and graphically evaluated to determine that remediated areas in RASSs 1, 2, and 4 are not becoming recontaminated. Potential sources were identified for suspected recontamination in Unit 13 (erosion of Nichols Creek and upgradient neighboring sources).

- **Objective 4 (evaluate contaminant migration in unremediated areas):** This objective was accomplished by collecting soil, sediment, and surface water samples throughout unremediated areas in a consistent manner over a 5-year period. These data were statistically and graphically evaluated to show that little change has occurred in concentrations in unremediated spatial units.

- **Objective 5 (monitor the overall habitat quality of the site, including the success of the restoration efforts and use of the site by special status plants and animals):** This objective was accomplished by conducting surveys and vegetation mapping throughout the Litigation Area and within the areas disturbed by remediation efforts. Results of revegetation surveys evaluated in comparison with specific success criteria indicated that most revegetation efforts were successful; however, there were a few exceptions. No specific goals were set as a measure of habitat quality, but surveys indicate the continued presence and use of the site by special status plants and animals; most populations of special status species were stable or increased over the 5 years of monitoring.

- **Objective 6 (determine if the groundwater is impacted by contamination):** This objective was accomplished by evaluating pre- and postremediation monitoring well samples, as described in the "Technical Memorandum: Tidal Influence Study and Postremediation Groundwater Monitoring" (PRC 1997b). Some groundwater contamination is present at the site; however, groundwater is moving very slowly and is not likely to impact Suisun Bay. Some off-site sources of groundwater contamination may be impacting the site.

6.3.5.2 Evaluation of Effectiveness of the Monitoring Program as Part of the Remedy

The intensive five-year post remediation monitoring program met the requirements of the RAP and ROD and adequately fulfilled the general objectives of the monitoring plan; however, this is not to say that the monitoring program was completely effective at addressing all concerns about the site.

The monitoring program was focused on sampling for chemicals and addressing concerns about migration of contaminants; to a great extent the chemical monitoring effort was successful at addressing these

concerns. The chemical monitoring program was designed without the knowledge that exists today about extent of contamination, potential for migration, and high degree of variability in chemical concentrations both laterally around sampling locations and vertically within the upper 6 inches. The vertical and lateral variation in chemical concentrations, for example, should be taken into account in the design of any additional sampling or remediation.

The monitoring program was developed before risk assessment guidance became available, and the focus of the ecological monitoring was not to address risk-oriented questions. Ecological monitoring was not intended or designed to measure any specific effect of metals contamination on populations of plants or animals in the Litigation Area. Annual monitoring on the scale that was conducted at the Litigation Area was also not sufficient to detect population changes in species and their causes. Ecological monitoring was successful in monitoring ecological conditions at the site, evaluating the recovery of active areas from the physical damage that incurred during the remediation effort, and tracking the ongoing presence of special status species.

Finally, the monitoring program was designed before the advent of the DQO process, and therefore would not meet today's standards for DQOs.

6.4 EVALUATION OF EXISTING SOURCES AND MIGRATION OF CONTAMINANTS

The removal actions conducted from 1993 to 1994 addressed the most contaminated soils in the Litigation Area, but left other contaminated soils in place at concentrations occasionally exceeding the cleanup criteria established for the site because of concerns about the adverse impacts to critical habitat. Potential mobility of chemicals associated with these remaining soils is an ongoing concern that the Navy has addressed through annual monitoring and special studies. Appendix E summarizes the special studies and investigations that have been conducted to assess mobility of contaminated soils, sediments, and groundwater and an evaluation of the potential for ongoing off-site sources of contamination to the Litigation Area. Findings and conclusions from Appendix E are summarized in the following sections.

6.4.1 Neighboring Properties as Continuing Source Areas

Several off-site neighboring properties are contaminated with the same metals that are present in the Litigation Area; these neighboring facilities were the original sources of contamination to Navy property (Figure 3). The potential for these neighboring facilities to act as ongoing sources of contaminants and the potential for migration from these properties to the Litigation Area was addressed by researching

agency files about each of the sites and through direct observation. Agency files on neighboring properties, including CPC, the Allied Signal/General Chemical facility, and GWF facility were reviewed. In addition, other potential source areas such as the railroad right–of-ways throughout the Litigation Area were researched.

The CPC site, directly southeast of the Litigation Area (Figure 3), was a former zinc recovery facility with an extensive history of environmental contamination problems. The site has high levels of metals in groundwater and stockpiled soil. The state (DTSC) has identified CPC property as having contamination with a high potential for off-site migration. The Litigation Area is downgradient from this site for both groundwater migration and surface runoff. As a result, the potential for migration of contaminants from this property to Nichols Creek and the Litigation Area is very high. The most contaminated groundwater reported is in a perched zone at the CPC site (Environmental Solutions, Inc. 1987), which is adjacent to an area where surface water in Nichols Creek frequently exceeded AWQCs for zinc (Figure 43). Interaction between groundwater in this perched zone and Nichols Creek has not been assessed.

The General Chemical Company site, directly east of RASS 1 (Figure 3), produced various acids, lead arsenate, and other chemicals and used on-site disposal to manage its wastes, including metals (aluminum, arsenic, chromium, mercury, and selenium) and organic chemicals. Contamination on the General Chemical Company property has a high potential for off-site migration. The Litigation Area is downgradient from this site based on potentiometric surface maps presented in a technical memorandum prepared by Montgomery Watson (Montgomery Watson 2000a). The file review did not include Honeywell, Inc. (owner of the waste lagoons adjacent to RASS 1) because the Navy was not aware of this property owner. Additional information is needed to evaluate the potential for ongoing sources from neighboring property on the eastern boundary of RASS 1.

The railroad companies still have high levels of metals on their right-of-ways (Figure 3), despite some remedial actions. In addition, ATSF never completed their remedial action in RASS 2, and the existing excavation sites are now surface water impoundments that present a risk for off-site migration onto Navy property. The RWQCB sampled surface water in these impoundments and found elevated concentrations of metals.

Aluminum-based powder was observed spilling from railcars parked on the ATSF side spur between RASSs 1 and 3. This powder is the likely source of high aluminum concentrations detected in surface water samples from the ditches and sloughs in RASS 1 (Appendix G).

6.4.2 Migration through Nichols Creek

Soils with concentrations exceeding TTLC, STLC, or SARAC cleanup criteria were removed along the bed of Nichols Creek during the remediation of RASS 3 in 1993 and 1994. The remediated area was recontoured, so that Nichols Creek flows along the same approximate creek bed that it flowed in before remediation. Visual observations of vertical escarpments, slump blocks, and erosional depressions (Figure 49) indicate that soils along Nichols Creek are currently eroding and mobilizing potentially contaminated soils. The most active areas of soil erosion are immediately north and south of the ATSF railroad tracks. The largest areas of eroding soils within this area of active erosion lie within the railroad right-of-ways that extend 50 feet on either side of the railroad tracks. Soils adjacent to these active erosional areas are contaminated with zinc at concentrations greater than four times the ER-M, and erosion of the creek bed obviously has the potential to mobilize these contaminated soils downstream. The bulk of sediments eroded from the banks of Nichols Creek appear to become trapped in the RASS 3 pond, which acts as a settling basin before discharging water to the marsh.

Nichols Creek flows along the border of the CPC property, creating the potential for contamination from the CPC site to migrate to the RASS 3 pond and to the RASS 1 marsh. Groundwater at CPC is contaminated with high concentrations of zinc (at up to 0.11 percent levels) and other metals. The dry season potentiometric surface map (Figure 67) and observation of water flowing in Nichols Creek adjacent to CPC at the end of the dry season indicates that Nichols Creek appears to interact with groundwater. As a result, contaminated groundwater from CPC property may affect Nichols Creek soils and groundwater in RASS 3.

6.4.3 Mobilization of Contaminated Sediments from the Marsh Surface

Ongoing postremediation monitoring has established that soils in some parts of the Litigation Area marsh are contaminated with high concentrations of metals at concentrations above cleanup criteria and current risk-based benchmarks. A sediment accretion study conducted in 1999 used isotopic and palynological techniques to show that the marsh is accreting sediments at a rate of approximately 2.5 millimeters (mm) per year in the three locations in the most contaminated southeastern portion of the marsh that were tested. XRF profiling of one of the three sediment cores showed that surficial sediments had lower concentrations of metals than the strata that correspond to the time of the spills, suggesting that contaminated sediment horizons have been progressively buried by cleaner sediments brought into the marsh from Suisun Bay. To test this hypothesis over a larger area, 10-inch sediment cores were collected at 13 locations on the marsh surface and divided into 10 1-inch sections. The 1-inch sections were dried,

composited, and analyzed by XRF techniques. The XRF profiles (Figures 52 through 55) demonstrate that metals concentrations decline both above and below a contaminated horizon 3 to 5 inches below the marsh surface, suggesting that the marsh is accreting cleaner sediments from Lost Slough and that the metals contamination in the marsh surface is not vertically mobile. The geographic distribution of elevated metals concentrations suggest that the primary source of zinc contamination is to the south of the Litigation Area marsh, the primary source of arsenic contamination is to the east of the Litigation Area marsh, and that copper and lead derive from both south and east of the marsh. The XRF profiles indicate that rather than being mobilized from the marsh surface, the contaminated marsh surface sediments are being progressively buried by cleaner sediments.

Marsh surface soils contain elevated concentrations of metals; however, the highest metals concentrations are located in horizons 3 to 5 inches below the surface and are becoming gradually buried by cleaner soils as a result of natural marsh accretion. The decrease in metals concentrations toward the marsh surface will reduce direct biotic exposure to metals. Dense vegetation at the marsh surface holds the soils in place; therefore, little, if any, uncontrolled migration of metals-contaminated soils is occurring at the existing marsh surface in RASS 1 and 2.

6.4.4 Mobilization of Sediments from Ditch and Slough Bottoms

To assess whether metals-contaminated sediments are mobile within the slough and ditch system, 10-inch sediment cores were collected in 7 evenly spaced locations along 3 ditches, for a total of 21 ditch bottom samples, and at 10 locations in Lost Slough. Metals profiles of the ditch and slough bottom samples (Figures 58 through 61 and 62 through 65) were more variable than the marsh surface cores.

Slough bottom sediments exhibit metals concentrations profiles at some locations that are similar to those of the marsh surface, suggesting that sediment in the marsh surface and the slough bottom have accreted through similar processes. However, the accretion of sediments on the slough bottom appears to be more localized than on the marsh surface. Sediment cores from the slough bottom that exhibit a peak in metals concentrations at depths of 4 to 6 inches below the surface are separated by cores with more or less constant metals concentration profiles or by profiles that show a moderate increase in concentrations with depth. This pattern indicates the slough bottom contains both depositional and erosional areas. High zinc concentrations in some parts of Unit 10 and Unit 11 suggest that portions of the slough are areas of net sediment accumulation and a sink for metals. However, uncontrolled migration of sediments may be occurring in other parts of the slough.

The ditch bottom sediment profiles indicate that sediments have eroded in some areas and have accumulated in others. Metals-contaminated sediments that have accumulated in the distal ends of the ditches have much higher metals concentrations than sediments that have accreted on the marsh surface, and they do not appear to derive from the same source. Concentration profiles in some parts of the northernmost mosquito ditch where sediments do not appear to have accumulated show some evidence of vertical mobilization of zinc, because high zinc concentrations were detected in deep sediment horizons that are presumed to predate industrial discharges into the marsh (Figure 61). An alternative explanation for the observed high zinc concentrations at depth is scouring and subsequent redeposition of contaminated sediments.

Surficial sediments in the ditches and sloughs typically have low metals concentrations compared with deeper sediments, indicating that rapid surface water flow across the ditch and slough bottoms that may occur during spring tides or storms is not likely to mobilize the most contaminated sediments. Surficial sediments at the distal ends of the ditches are among the most contaminated at the site, and rapid surface water flow could mobilize these sediments. However, the shallow depths at the distal ends of the ditches suggest that these are areas of sediment accumulation rather than mobilization.

Accumulation of sediment has occurred in some parts of the ditches and erosion has occurred in others. Calving of ditch edges and parts of the ditches that are currently deeper than when they were installed indicates that uncontrolled migration of ditch sediments is occurring in some locations. Much of Unit 11 in Lost Slough appears to be an area of net sediment accumulation; however, the possibility of uncontrolled migration from this area cannot be ruled out.

6.4.5 Migration of Contaminants to Suisun Bay through Surface Water of Lost Slough

To determine whether Lost Slough acts as a conduit that conveys contaminants from the Litigation Area marsh to Suisun Bay, the Navy collected tidal water quality samples at the mouth of Lost Slough during the winter of 1998 to 1999 and the fall of 2000. Both sets of samples showed the same general features; the quality of water entering and exiting the Litigation Area marsh during both sampling events was generally comparable (Table 23). A large proportion (almost 70 percent) of the analytical results for the winter of 1998 to 1999 were either below detection limits or were qualified as nondetected during data validation. Detection limits and detected concentrations were lower than AWQC for all metals except copper, indicating that water entering and exiting the Litigation Area marsh does not exceed applicable water quality criteria. Almost 95 percent of the analytical results from the fall of 2000 were below detection limits, and detection limits were lower than AWQC for all metals, except copper. Copper

concentrations exceeded AWQC in both incoming and outgoing tides. Copper concentrations were comparable and exceeded AWQC in a single tidal cycle where copper was detected in both incoming and outgoing tides, indicating that the Litigation Area marsh does not export copper to Suisun Bay.

RWQCB collected samples at two nearby locations during the fall of 2000 tidal water quality sampling event, but used a different analytical technique that consistently achieved lower detection limits. RWQCB samples showed that no dissolved metals concentrations exceeded AWQC, and that metals concentrations in incoming tides were comparable with concentrations in outgoing tides (Table 24). RWQCB samples showed no significant difference between samples collected at the junction of Lost Slough, with the north-south cut that leads to the bridge sampling location, and a different location further from the mouth of Lost Slough.

Samples collected to date strongly suggest that the Litigation Area marsh does not export significant concentrations of metals to Suisun Bay through Lost Slough. Detected concentrations in incoming tides were generally comparable with those in outgoing tides. For copper, the analytical laboratory used by the Navy was unable to achieve a low detection limit; therefore, the conclusion that copper concentrations in incoming tides are comparable with those in outgoing tides is based on a limited number of samples. However, this conclusion is supported by three sets of samples collected and analyzed by RWQCB that show that copper concentrations in incoming and outgoing tides were for all practical purposes identical; concentrations were below AWQC (3.1 micrograms per liter [µg/L]).

While it does not appear that the Litigation Area marsh is exporting metals in surface water to Suisun Bay, there are surface water quality concerns within the site. As discussed in Section 6.6, surface water samples in the ditches and sloughs in the more contaminated southern portion of RASS 1 and in Nichols Creek do exceed chronic and acute AWQC. Water with relatively high concentrations of dissolved metals moves back and forth in the slough and ditches in response to rising and falling tides, but does not appear to export significant contamination to Suisun Bay. Any surface water that does exit the slough appears to be significantly diluted with less contaminated water.

6.4.6 Groundwater Issues

Groundwater in the Litigation Area generally flows to the north or northwest toward the tidal wetlands (Figures 67 and 68). Migration of groundwater in the Litigation Area marsh is not considered a major migration pathway at the site because groundwater flow velocities are very slow (on the order of 2.3 feet per year) and groundwater discharge to the sloughs and mosquito ditches and subtidal discharge along the shoreline is likely to be very small compared with the volume of flowing surface water. Groundwater in

the Litigation Area is contaminated with metals (Attachment E3). The concentrations of these metals declined significantly after remediation of metals-contaminated soils. However, concentrations of some metals in groundwater still exceed AWQC. The General Chemical Company and CPC sites are directly upgradient from the Litigation Area, and recent investigations show that groundwater at these sites is contaminated with very high concentrations of the same metals that are present in the Litigation Area. These off-site sources are likely to affect groundwater in the Litigation Area.

Groundwater in the Litigation Area has not been formally classified, but is likely to be considered nonpotable because wells in the Litigation Area marsh exhibited TDS concentrations greater than 10,000 milligrams per liter and most wells are screened in a silty clay formation that cannot sustain a yield of 150 gallons per day. Groundwater wells have not been sampled since 1996, so current flow rates and groundwater quality conditions are not known.

6.4.7 Conclusions on Existing Sources and Contaminant Migration

The State of California has documented and the Navy review has supported the idea that the abandoned CPC facility and the operating General Chemical facility currently have high levels of contaminants remaining on their properties. In addition, the State of California has stated that a high potential exists for off-site migration from the CPC facility. Since the Navy's property is downgradient from CPC, a high potential exists that the migration of metals may affect Navy property.

Nichols Creek in RASS 3 is an area of uncontrolled migration of contaminants in soil and surface water because the creek is actively eroding areas of contaminated soil. In addition, the CPC facility is upgradient and is likely to be contributing contaminated surface runoff and groundwater to Nichols Creek.

Contaminants on the marsh surface are being buried by cleaner sediment; the highest metal concentrations were detected at 3 to 5 inches bgs. The presence of dense vegetation on the marsh surface and vertical profile of contamination indicate that little migration of contaminants from the marsh surface is occurring.

Uncontrolled migration of contaminants in the ditch and slough bottom sediments may occur, since vertical profiles indicate areas of sediment erosion and accumulation. Little evidence exists that contaminated sediments are migrating all the way out of Lost Slough to Suisun Bay because tidal water quality sampling does not indicate that the site is exporting significant amounts of contaminants through the surface water pathway.

As a result of very slow groundwater flow rates, discharge to surface water bodies is likely to be very limited. Therefore, groundwater contamination does not appear to pose a major problem in the Litigation Area marsh. However, high concentrations of metals in groundwater at the neighboring, upgradient CPC facility may migrate into the Litigation Area or discharge into Nichols Creek through the perched zone. Current groundwater conditions at the Litigation Area are not known since groundwater has not been sampled since 1996; the Navy plans to conduct additional investigation of Litigation Area groundwater and the potential for groundwater-surface water interactions near the border of CPC and Navy property (Section 10.2).

6.5 RESULTS AND CONCLUSIONS OF THE HUMAN HEALTH RISK ASSESSMENT

As part of the five-year review process, a screening-level HHRA was conducted to evaluate whether significant risk exists to human receptors from contaminants at the Litigation Area based on existing (postremediation) conditions. A quantitative HHRA was not previously conducted as part of the RI or other investigations at the Litigation Area, which focused primarily on impacts to ecological receptors. The objective of the screening-level HHRA was to assess risks from potential exposures to contaminants detected in surface soils, sediments, and surface water in RASSs 1 through 4. The complete HHRA is presented in Appendix F.

The approach for the HHRA was developed in consultation with the regulatory agencies (TtEMI 2000d). Risks were evaluated for potential receptors identified based on current and possible future land-use scenarios. Naval Weapons Station SBD Concord is an active naval base and is not scheduled to close, so future land use at the Litigation Area sites is not expected to change from current use. The primary receptor identified under current and expected future land-use conditions was a worker present intermittently at the Litigation Area. EPA and DTSC requested that commercial/industrial worker and residential receptors also be evaluated to provide information to support decisions on the need for restrictions if land use were to change in the future. Further, the regulatory agencies requested that the risks associated with exposure to soil, sediment, and surface water be evaluated separately for each sampling location within the Litigation Area.

The assessment was conducted using the following two-tiered approach that was designed to meet the objectives of the risk assessment and to address the specific concerns of the agencies:

- **Tier 1 – Preliminary Remediation Goal (PRG) Screen.** Risks to residential and industrial worker receptors were evaluated by comparing concentrations of each contaminant detected in soil and sediment with EPA Region IX residential and industrial PRGs for soils (EPA 2000). Surface water concentrations were compared with the Region IX tap water PRGs. The PRGs were used to estimate cancer risks and hazard indices (HI) (a measure of noncancer health effects) at each sampling location for soil, sediment, and surface water. The Tier 1 PRG screen evaluated risks to potential receptors under the unlikely assumption that land use at the Litigation Area may change in the future.

- **Tier 2 – Risk-based Concentration (RBC) Screen.** Risks to a site-specific receptor, identified on the basis of current land use at the Litigation Area, were evaluated by developing receptor-specific RBCs for soil, sediment, and surface water. The RBCs were developed using exposure parameter values specific to a current receptor in place of the default exposure values used to develop the Region IX PRGs. Similar to the Tier 1 screen, the RBCs were used to estimate cancer risks and HIs at each soil, sediment, and surface water sampling location.

A sitewide CSM that integrated information for each of the RASSs was developed to support the HHRA (Figure 15). The CSM provides details about historical sources and release mechanisms, current sources and release mechanisms, receiving and affected media, and exposure pathways and receptors.

All inorganic chemicals detected at concentrations greater than ambient levels (PRC 1996a, 1996c) and all detected organic chemicals were evaluated in the Tier 1 screen. A more limited suite of those chemicals, comprising those chemicals contributing significantly to the risk estimates, was evaluated in the Tier 2 screen. Cancer risks and HIs were estimated separately for each sampling location, and the results were plotted on Figures 69 through 71 (Tier 1) and Figures 73 and 74 (Tier 2). The evaluation of lead was conducted by comparing the concentration of lead in soil with the EPA Region IX PRGs of 400 and 750 mg/kg for a residential receptor and a commercial/industrial worker receptor (EPA 2000). Lead concentrations in soil are shown on Figure 72. The following sections summarize the results and conclusions of the screening-level HHRA.

6.5.1 Results of the Tier 1 Preliminary Remediation Goal Screen

Cancer risk estimates and HIs were prepared for resident and commercial/industrial worker receptors. However, industrial or residential development of RASS 1, which comprises marsh and wetland areas, would require placement of several feet of fill over the existing surface. Further, a change in land use is unlikely due to the wetland habitat and presence of endangered species. Although portions of RASSs 2, 3, and 4 could be developed for residential or industrial use without significant modification of the existing topography, future development is considered highly unlikely, particularly in RASSs 2 and 3. Similar to RASS 1, development of marsh and wetland areas within RASSs 2, 3, and 4 would require

placement of fill. Thus, the risk estimates for the resident and industrial worker receptors are provided for reference, but should not be considered representative of the potential risks to these hypothetical receptors if land use were to change in the future.

The residential and industrial scenarios addressed the same exposure pathways: incidental ingestion of soil, dermal contact with soil, inhalation of airborne soil particles as dust, and inhalation of volatile organic compound (VOC) released directly from soil and sediment. Ingestion of surface water (assumed to be used as the source of drinking water) was also evaluated for the residential receptor.

As shown on Figure 69, cancer risks for the residential receptor were greater than the upper end of the risk management range (1×10^{-6}), and the HIs were greater than 1 over extensive areas of RASSs 1, 2, 3, and 4. Arsenic was the single major contributor to the cancer risk and the HI at almost all locations, and incidental ingestion of soil was the major exposure pathway. Cancer risks for residential exposures to surface water were also greater than the upper end of the risk management range (1×10^{-4}), and HIs were greater than 1 at almost all locations sampled (Figure 71). Arsenic was also the primary contributor to the cancer risk and the HI for surface water. Surface water in the sloughs, ditches, and impoundments at the Litigation Area is not potable, so the Tier 1 screen for surface water (which is based on tap water PRGs) yields extremely conservative estimates of potential risk. Concentrations of lead in soil and sediment were less than the EPA Region IX PRGs of 400 mg/kg (EPA 2000) at most locations within RASSs 1 through 4; concentrations were greater than the PRG at a limited number of locations (Figure 72). The maximum concentration of lead was detected in RASS 2 at 6,060 mg/kg.

As shown on Figure 70, cancer risks for the commercial/industrial worker receptor were less than or within the risk management range (1×10^{-6} to 1×10^{-4}), and HIs were less than 1 in most areas of RASSs 1 through 4. The exceptions were Spatial Units 6 (central marsh surface soil), 7 (central marsh ditch sediment), 8 (RASS 1 active remediation area surface soil) and 11 (southwestern reach of Lost Slough) within RASS 1, where cancer risks were greater than 1×10^{-4} and HIs were greater than 1. Although much of Spatial Unit 8 was in the active remediation area, this unit abuts Spatial Unit 6 to the west, an area of particularly high contamination. Sampling design and subsequent errors resulted in some of the samples being collected outside of the active remediation area (in Unit 6), instead of along the western boundary of Spatial Unit 8. Concentrations of lead in soil and sediment were less than the EPA Region IX PRG of 750 mg/kg at most locations within RASSs 1 through 4 (Figure 72). However, concentrations were greater than the PRG at a few locations.

6.5.2 Results of the Tier 2 Risk-based Concentration Screen

A mosquito abatement worker receptor was selected to represent the reasonable maximum exposure receptor at the Litigation Area under both current and expected future land-use conditions. This worker receptor was identified as the most exposed receptor on the basis of information provided by Naval Weapons Station SBD Concord and CCCMVAD (TtEMI 2001a, 2001b). Exposure pathways evaluated for this receptor were incidental ingestion of soil, dermal contact with soil, inhalation of airborne soil particles as dust, and inhalation of VOCs released directly from soil and sediment. Incidental dermal contact with surface water was also evaluated. Exposure parameters for the mosquito abatement worker were developed on the basis of information provided by CCCVMAD (TtEMI 2001a). This information included the type of clothing worn by the workers (long-sleeved shirts, long pants, steel-toed hip waders, goggles, gloves, and generally dust/mist masks) and the activities conducted (sampling and spraying). The exposure assumptions specific to the mosquito abatement worker included exposure frequency (30 days per year), exposure time (6 hours per day), soil ingestion rate (100 milligrams per day), and exposed skin surface area (2,100 square centimeters).

Although mosquito abatement activities occur only in RASS 1, the mosquito abatement worker receptor was used to evaluate potential risks in RASSs 2, 3, and 4. That is, the mosquito abatement worker receptor is considered a surrogate for other receptors that enter RASSs 2, 3, and 4 intermittently and conduct activities resulting in similar types of exposure. No worker or other authorized individual routinely access RASSs 2, 3, or 4; as a result, risks for the mosquito abatement worker receptor represent upperbound estimates of risks to other potential receptors under current site conditions.

During the site inspection tour on July 27, 2001, the Navy and the regulatory agencies observed evidence of trespassing at RASS 4 (Section 6.1.1). However, because the Navy plans to take measures to remedy access controls at RASS 4 (Section 10.3), a trespasser scenario was not specifically evaluated in the Tier 2 RBC screen. The risks estimated for the mosquito abatement worker provide a rough estimate of potential risks to trespassers. These risks are based on assumptions of intermittent access and exposure to soil.

Cancer risks for the mosquito abatement worker receptor from exposure to surface soil and sediment were less than or within the risk management range (1×10^{-6} to 1×10^{-4}), and HIs were less than 1 in most areas of RASSs 1 through 4 (Figure 73). The exceptions were Spatial Units 6 (central marsh surface soil), 7 (central marsh ditch sediment), and 8 (RASS 1 active remediation area surface soil), where cancer risks were greater than 1×10^{-4} and HIs were greater than 1 at some sampling locations.

The Tier 2 screen evaluated risks at each sampling location. However, the mosquito abatement worker receptor would not be exposed at only a single location over the course of a year. That is, the worker would be exposed for only a short period at any one location while conducting inspection and spraying activities. Potential risks to the mosquito abatement worker are better interpreted using percentiles to describe the distribution of risks (Tables 39 and 40). The 50th and 95th percentile cancer risks were 1×10^{-5} and 1×10^{-4} at RASS 1, 6×10^{-6} and 5×10^{-5} at RASS 2, 1×10^{-6} and 1×10^{-5} at RASS 3, and 4×10^{-6} and 2×10^{-5} at RASS 4. The HIs corresponding to the 95th percentile were less than 1 at all four RASSs. Cancer risks from incidental exposure to surface water were less than the lower end of the risk management range (1×10^{-6}) and HIs were less than 1 at all sampling locations (Figure 74).

6.5.3 Protectiveness of the Existing Remedy

A specific goal of the five-year review was to evaluate whether selected remedies, which included active remediation and the decision to leave some contamination in place (passive remediation), were protective of human health. Because an evaluation of protectiveness is related to land use, the discussion addresses the protectiveness of the remedy under current site conditions (represented by the mosquito abatement worker scenario) and under the unlikely assumption that land use at the Litigation Area changes in the future (represented by the commercial/industrial worker and residential scenarios). Residential or industrial development of the wetland areas in RASSs 1 and 2 is very unlikely.

6.5.3.1 Remedial Action Subsite 1

Spatial Unit 8 was the only area of active remediation in RASS 1. Estimated risks and HIs for both current (mosquito abatement worker) and possible future (commercial/industrial worker and resident) receptors in this area were less than the risk management range at all locations within this unit. A direct comparison with risks before remediation cannot be made because an HHRA was not previously conducted. However, a comparison of the risks in the area of active remediation with the risks in all other areas of RASS 1 indicates that remediation effectively reduced risks associated with potential exposures to soil. Spatial Unit 8 abuts Spatial Unit 6 to the west, an area of particularly high contamination, and cancer risks were greater than the risk management range and HIs were greater than 1 for both the commercial industrial worker and resident receptors at sampling locations at the interface of Spatial Units 6 and 8.

Passive remediation was the selected remedy in all other areas of RASS 1. Under current land-use conditions, cancer risks were within the risk management range and HIs were less than 1 at most locations. However, environmental conditions throughout extensive areas of RASS 1 may pose an

unacceptable risk to human health if land-use conditions were to change in the future, particularly if the area were developed for residential use. However, a future residential scenario is unlikely because of the wetland habitat and the presence of endangered species in RASS 1. Further, development of this area would require placement of fill materials over the existing marsh surface.

6.5.3.2 Remedial Action Subsite 2

Active remediation was conducted in the central portion of RASS 2. Estimated cancer risks for both current (mosquito abatement worker) and possible future (commercial/industrial worker and resident) receptors in the northern portion of the remediated area were less than the risk management range, and HIs were less than 1. Although a direct comparison cannot be made to risks before remediation, the remedy effectively reduced risks associated with potential exposures to soil in this area to levels that do not pose an unacceptable risk to human health. However, environmental conditions within some portions of both the active and passive remediation areas may pose an unacceptable risk to human health if land-use conditions were to change in the future.

6.5.3.3 Remedial Action Subsite 3

Active remediation was conducted throughout most of RASS 3 along Nichols Creek. Environmental conditions within both the active and passive remediation areas do not pose an unacceptable risk to human health under current land-use conditions. Under the assumption that land-use conditions change in the future, areas remain in RASS 3 that may pose an unacceptable risk to human health.

6.5.3.4 Remedial Action Subsite 4

Active remediation was conducted in two discrete areas of RASS 4. Environmental conditions in both the active and passive remediation areas do not pose an unacceptable risk to human health under current land-use conditions, assuming adequate measures are implemented to restrict access of unauthorized persons. Under the assumption that land-use conditions change in the future, areas remain in both the active and passive remediation areas that may pose an unacceptable risk to human health. Risks in the area of active remediation are not substantially different from those in the area of passive remediation.

6.5.4 Conclusions of the Human Health Risk Assessment

The following conclusions were based on the findings of the Tier 1 PRG and Tier 2 RBC screens conducted for RASSs 1 through 4:

- **Risks to Human Health under Current Site Conditions:** Under the assumption that current land-use and site conditions remain unchanged and adequate measures are implemented to restrict access of unauthorized persons, estimated cancer risks and noncancer HIs for current receptors, as represented by the mosquito abatement worker, are within or less than risk management levels. These risk findings indicate that current environmental conditions at the Litigation Area do not pose an unacceptable risk to human health based on the continued use of this area as a buffer zone with restricted access.

- **Risks to Human Health under Changed Site Conditions:** Under the assumption that land use changes in the future, estimated cancer risks and noncancer HIs for a resident and a commercial/industrial worker exceed risk management levels considered protective of human health in some areas of each of RASSs 1 through 4.

6.6 RESULTS AND CONCLUSIONS OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

As part of the five-year review process, a focused BERA was conducted to determine whether significant risk exists to ecological receptors from contaminants remaining at the Litigation Area. The BERA refined the results of the QEA (PRC 1997c) and focused on chemicals identified as risk drivers in the QEA, including the six metals, mercury, total DDTs, total PCBs, and total Aroclors. The purpose of conducting the BERA was to determine whether remedial actions conducted to date were protective of ecological receptors and whether any additional actions are necessary to protect the environment. The following sections summarize the results and conclusions of the BERA, and complete results of the BERA are presented in Appendix G.

6.6.1 Problem Formulation

The QEA (PRC 1997c) satisfied requirements of steps 1 and 2 of CERCLA ERA guidance (EPA 1997a). Conclusions set forth in the QEA and the need to better define risks for the five-year review were the basis for undertaking additional evaluation of ecological risk at the Litigation Area under steps 3 through 8 of the ERA process. Step 3, Baseline Risk Assessment Problem Formulation, resulted in a scientific management decision point wherein agreement was reached among the risk assessors, the risk managers, and other involved parties with respect to four key items: (1) assessment and measurement endpoints, (2) exposure pathways, (3) risk questions, and (4) CSMs. During problem formulation for the BERA, these four items were addressed for three broad groups of receptors: (1) upland and wetland plants, (2) fish and aquatic invertebrates, and (3) birds and mammals. The approach for conducting the BERA was presented in the draft final work plan (TtEMI 2000d).

The sitewide ecological CSM provides details about exposure routes for specific assessment endpoints (Figure 16). The CSMs for each of the four RASSs incorporate information about historical and current

sources, release mechanisms, and affected media (Figures 17 through 20). Risk questions and assessment and measurement endpoints for upland and wetland plants, fish and aquatic invertebrates, and birds and mammals are summarized in Tables 46, 48, and 50. The BERA only assessed risk from the six metals, mercury, total DDTs, and total PCBs and total Aroclors.

6.6.2 Risk to Plants

Results of the exposure and effects assessment presented in Section 4.0 of Appendix G do not indicate unacceptable risk to populations of upland and wetland plants from metals in sediment and soil at the Litigation Area. Four lines of evidence were used to evaluate risk to upland and wetland plants at individual locations across the Litigation Area: (1) results of plant surveys conducted during the 5 years of postremediation monitoring, (2) calculation of bioaccumulation factors (BAF) for collocated soil or sediment and plant tissues samples, (3) comparison of tissue concentrations of metals with effects levels from the literature, and (4) comparison of soil concentrations of metals with Oak Ridge National Laboratory (ORNL) benchmarks (Efroymson, R.A. and others 1997). Conclusions about effects to the population level of plants were based on the following:

1. The extent to which different plant species are collocated with areas of the site where elevated concentrations of metals are common in soil and sediment.
2. The proportion of locations within a habitat where the potential for bioaccumulation of toxicologically significant concentrations of metals poses unacceptable risk.
3. The proportion of locations within a habitat that show unacceptable risk based on comparison of exposure point concentrations of metals in soil or sediment and tissue with probable effects levels (ORNL benchmarks and literature studies).

A weight-of-evidence summary for characterizing risk to plants from inorganic chemicals of potential ecological concern (COPEC) is provided in Table 107.

The tidal wetland in RASS 1 has high habitat value, which is reflected by the high diversity of plant species that has been recorded during 5 years of ecological monitoring and the presence of special status species, including four rare plant species and mammals (such as the salt marsh harvest mouse) that depend on the pickleweed-dominated plant associations. Common pickleweed, which was selected as a representative species for wetland plants, is found in all areas of the wetland that provide a suitable habitat, including areas in the southeastern portion of RASS 1 where high concentrations of arsenic and zinc are common in soil and sediment. Moreover, soil:pickleweed BAFs indicate that metals are not being significantly accumulated in this species (all BAFs less than 1.0, as shown in Table 70). Several areas in the southeastern portion of RASS 1 (Unit 6) and in RASS 2 (Unit 12) have high levels of metals

that exceed ORNL benchmarks and effects levels reported in the literature (Figure 77 and Table 69). Selected locations in Units 6 and 12 may pose some unacceptable risk to individual plants; however, effects to the population level for any wetland species are not considered likely.

Two of the four special status plant species at the Litigation Area, Mason's lilaeopsis and the delta tule pea, are only found along the northern margin of the marsh surface in RASS 1, where appropriate habitat exists. Concentrations of metals are low in these areas and do not pose an unacceptable risk to wetland plants (Figure 77). Soft bird's beak is found in the northwestern region of RASS 1 at a few locations along the main reach of Lost Slough, and it has actively recolonized the remediated portion of RASS 1 in Unit 8. Soft bird's beak has generally shown an increase in population size during the 5 years of postremediation monitoring and, because most stands are in areas with relatively low concentrations of metals in soil, unacceptable risk is not indicated for this species. Suisun marsh aster has spread along Lost Slough in Unit 11 and the ditches in Unit 7 in areas where arsenic and zinc concentrations are elevated. Stands of Suisun marsh aster also occur in other areas across the marsh surface in RASS 1 where concentrations of metals are below a level of concern. Based on the expansion of marsh aster into areas of the site with high metal concentrations and the existence of stands in areas with relatively low concentrations of metals, unacceptable risk is not indicated for this species.

Upland plant communities at the Litigation Area are typical of disturbed areas dominated by nonnative grasses. At some locations, individual plants may be affected by concentrations of contaminants that exceed the ORNL benchmarks; however, no special status plant species are found in the upland areas, and the habitat quality is low.

6.6.3 Risk to Fish and Invertebrates

Results of the exposure and effects assessment presented in Section 5.0 of Appendix G do not indicate effects to the population level of fish and aquatic invertebrates from DDTs, PCBs, and Aroclors in sediment at the Litigation Area. However, the results do suggest that elevated concentrations of metals in sediment and surface water may pose some unacceptable risk at selected locations in the main reach (Unit 10) and western arm (Unit 11) of Lost Slough.

Lines of evidence used to assess risk from exposure to organic COPECs at individual locations at the Litigation Area included (1) measured or estimated concentrations of total DDTs and PCBs and Aroclors in sediment and soil (Tables 58 through 62), (2) estimates of bioaccumulation potential for total DDTs and PCBs based on sediment:tissue BAFs calculated for selected vertebrate and invertebrate species, and (3) comparison of sediment concentrations of total DDTs and PCBs and Aroclors to toxicity benchmarks

(Figures 79 and 80). Conclusions that organic COPECs in sediment and soil do not pose unacceptable risk to populations of fish and aquatic invertebrates were based on the low detection frequencies of DDTs, PCBs, and Aroclors across the site, as well as the generally low concentrations that have been measured or estimated for these chemicals. Comparison of the relative risk posed by organic versus inorganic COPECs was also performed as part of the BERA (Figures 79 through 81), and supports the conclusion that organic COPECs are below a level of concern at the Litigation Area. A weight-of-evidence summary of the risk characterization for fish and aquatic invertebrates exposed to organic COPECs is provided in Table 108.

Lines of evidence used to assess risk from exposure to inorganic COPECs in sediment and surface water at individual locations at the Litigation Area included (1) direct measures of toxicity from two amphipod (*Eohaustorius estuarius* and *Hyalella azteca*) bulk sediment bioassays and one topsmelt (*Atherinops affinis*) sediment-water interface bioassay; (2) estimates of the bioaccumulation potential of metals based on the calculation of sediment:tissue BAFs for clams, fish, crayfish, amphipods, and damselfly nymphs; and (3) comparison of concentrations of metals in sediment and surface water with appropriate sediment (ER-L, ER-M, and ER-M_q) (Long and others 1995; Long and MacDonald 1998) and surface water (AWQC) benchmarks (Tables 10A and 10B). Simultaneously extractable metals and acid volatile sulfides differences were also calculated at selected locations to estimate the available fraction of metals in sediment. The fraction of metals measured in sediment pore water and recovered in sediment extracts (waste extraction test for deionized water) was used to estimate the potential for leaching of metals and as an additional estimate of availability. Effects to the population level of fish and aquatic invertebrates were assessed based on (1) the frequency and magnitude of detected concentrations exceeding threshold criteria established for individual lines of evidence, and (2) the proportion of locations within each spatial unit or habitat where threshold criteria were exceeded for individual lines of evidence. A weight-of-evidence summary of the risk characterization for fish and aquatic invertebrates exposed to inorganic COPECs is provided in Table 109.

Toxicity tests using amphipods showed unacceptable risk to aquatic invertebrates at one of four locations in Unit 10 and at two of four locations in Unit 11 in Lost Slough; however, at most of these locations the magnitude of detected concentrations exceeding threshold levels of concern defined for each bioassay was low (Tables 80, 81, and 84). Amphipod toxicity test results showed no unacceptable risk to aquatic invertebrates at six locations in the Unit 7 ditches, three locations in Unit 9 in Lost Slough, two locations in the RASS 3 pond, one location in the RASS 4 wetland, and nine locations on the marsh surface (Units 1, 2, 4, and 6). Results from topsmelt sediment-water interface bioassays showed no unacceptable

risk to fish at any location tested (three locations in Unit 9, four locations in Unit 10, one location in Unit 11 in Lost Slough, and two locations in the RASS 3 pond) (Table 78).

Some unacceptable bioaccumulation in clam tissue was reported for arsenic, copper, mercury, and zinc in Unit 9; mercury in Unit 10; and copper and selenium in Unit 11 in Lost Slough; however, most BAFs were only slightly greater than 1.0 (Tables 74 and 75). Only mercury was detected in one sample from Unit 10 with a BAF that exceeded the threshold level of concern by a wide margin (BAF equal to 14.3). Some unacceptable bioaccumulation was found for mercury and selenium in stickleback tissue and for copper in crayfish tissue from the RASS 3 pond; for both the stickleback (*Gasterosteus aculeatus*) and crayfish, all BAFs were less than 5.0 (Table 76).

Bulk sediment chemistry results show widespread detections of concentrations exceeding sediment benchmarks based on the ER-M and ER-M_q from most spatial units in all habitats (Figures 22 through 33 and Figures 83 and 84). Concentrations of metals in sediment are highest in Units 10 and 11 in Lost Slough and in Units 6 and 7 in the southeastern portion of RASS 1. Concentrations of metals in sediments, however, are poorly correlated with measured effects in bioassays, and bulk chemistry alone cannot be used to predict unacceptable risk at the site. Mobility and transport of contaminated sediment may increase the bioavailability potential of metals and should be considered a risk factor in the Unit 7 ditches, Lost Slough (Units 10 and 11), and along Nichols Creek downstream from CPC property (Unit 13).

Surface water chemistry results show widespread detections of total concentrations exceeding AWQCs for arsenic, copper, and zinc in the ditches (Units 3, 5, 7), Lost Slough (Units 9, 10, and 11), and Nichols Creek (copper and zinc only) (Figures 38 through 43). However, elevated concentrations of total metals in surface water above AWQC overestimate the bioavailable fraction of metals compared with measures of dissolved concentrations. Elevated concentrations of dissolved copper above AWQC were found in the ditches (Unit 7), Lost Slough (Units 9, 10 and 11) and Nichols Creek; the concentrations may pose some unacceptable risk to aquatic receptors in these areas. However, detection limits for dissolved copper were usually greater than AWQC, and many of the reported concentrations that exceeded either acute or chronic AWQC for copper were based on nondetect samples.

The co-occurrence of toxicity in amphipod bioassays, unacceptable bioaccumulation potential, and elevated concentrations of metals in sediment and surface water at some locations was the basis for concluding that portions of the western arm (Unit 11) and main reach (Unit 10) of Lost Slough may pose some unacceptable risk to populations of aquatic receptors. The magnitude of effects observed in toxicity

tests was small; however, the spatial extent of chemical concentrations exceeding criteria and the multiple lines of evidence suggesting unacceptable risk in Units 10 and 11 indicate the potential for effects to the population level of fish and aquatic invertebrates (Figure 93).

While some elevated concentrations of chemicals were found in Units 3, 5, 7, 9, and the RASS 3 pond (Unit 13), unacceptable effects to the population level of fish and aquatic invertebrates are not indicated in these areas. Unit 7 (ditches) and the RASS 3 pond may act as on-site sources of contaminants to Lost Slough.

6.6.4 Risk to Birds and Mammals

Results of the exposure and effects assessment presented in Section 6.0 of Appendix G do not indicate effects to the population level of birds and mammals from DDTs, PCBs, and Aroclors in sediment and soil at the Litigation Area. Some unacceptable risk from exposure to metals may exist for the California Black Rail (risk driver is zinc) and the Suisun Song Sparrow (*Melospiza melodia maxillaris*) (risk driver is selenium) along areas of the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Unit 5 and Unit 7. Some unacceptable risk was indicated for individual salt marsh harvest mice from arsenic at a small number of locations in Unit 6; however, population-level effects were not indicated for the harvest mouse.

Risk from exposure to inorganic and organic COPECs was assessed at individual locations at the Litigation Area using food-chain modeling. The primary line of evidence used in this assessment was comparison of an estimated ingested dose for individual inorganic and organic COPECs with the high TRV. For inorganic COPECs showing unacceptable risk based on food-chain modeling, back calculations were performed to identify locations where sediment or soil concentrations at the site would result in HQs greater than 1.0 using the high TRV. Population-level effects from exposure to inorganic and organic COPECs were assessed by (1) estimating the fraction of each receptors habitat where risk was determined to be unacceptable based on calculation of an HQ (dose/TRV_{high}) greater than 1.0, (2) consideration of the magnitude by which calculated doses exceeded the TRV_{high}, and (3) consideration of the specific factors (that is, elevated concentrations of COPECs in prey tissue and soil or sediment) responsible for HQs that exceed 1.0. For special status species, effects to individuals were also assessed. Food-chain modeling results for inorganic and organic COPECs are summarized in Tables 98 through 106. Weight-of-evidence summaries for characterizing risk to birds and mammals from exposure to organic and inorganic COPECs are provided in Tables 111 and 112.

All estimates of the ingested chemical dose for the Mallard (*Anas platyrhynchos*), Great Blue Heron (*Ardea herodias*), American Kestrel (*Falco sparverius*), Northern Harrier (*Circus cyaneus*), salt marsh harvest mouse, and river otter (*Lutra canadensis*) were less than the TRV_{high} for DDTs and PCBs. The ingested dose for the California Black Rail was also less than the TRV_{high} for DDTs. The TRV_{high} for PCBs was exceeded for the California Black Rail when the ingested dose was calculated by estimating concentrations of PCBs in amphipod tissue using a literature-derived BAF. However, population-level effects were not indicated for this species because (1) unacceptable risk was only present at a small number of locations within the range of Black Rail at the Litigation Area, (2) the HQ calculated using estimated concentrations of PCBs in prey tissue did not exceed 1.0 by a significant margin, and (3) unacceptable risk was not indicated when the ingested dose was calculated using an alternate dietary scenario based on site-specific clam tissue.

No unacceptable risk to populations of Mallard, Great Blue Heron, American Kestrel, Northern Harrier, gray fox (*Urocyon cineroargenteus*), and river otter was indicated for any inorganic COPEC; all estimated ingested doses were less than the respective TRV_{high} for each COPEC. Some unacceptable risk from arsenic, cadmium, copper, lead, and zinc was indicated for California Black Rails using areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7 (Figure 94). Zinc was the primary risk driver for the Black Rail. Some unacceptable risk from copper, selenium, and zinc was indicated for Suisun Song Sparrows at the same areas identified for the Black Rail (Figure 94). Selenium was the primary risk driver for the Song Sparrow. Some unacceptable risk from arsenic was indicated for the salt marsh harvest mouse at five locations in Unit 6.

Based on back calculations of the number of locations where HQs were exceeded and the magnitude by which HQs exceeded the threshold of concern established for this line of evidence (that is, dose/TRV_{high} greater than 1.0), it was concluded that some population-level risk may be indicated for both the California Black Rail and the Suisun Song Sparrow along selected areas of Lost Slough (Units 9, 10, and 11) and the ditches (Units 5 and 7). Unacceptable risk was indicated for individual salt marsh harvest mice from exposure to arsenic at some locations in Unit 6, but risk to populations of harvest mice was not indicated based on (1) findings of unacceptable risk at only five locations in Unit 6, and (2) the areawide HQ calculated for Unit 6 was only marginally greater than 1.0.

6.6.5 Protectiveness of the Active Remediation

The effectiveness of active remediation in reducing levels of risk to plants, fish and aquatic invertebrates, and birds and mammals was evaluated for each RASS area:

6.6.5.1 Remedial Action Subsite 1

Remediation of contaminated soil in Unit 8 in RASS 1 has been effective in reducing concentrations of metals, and existing levels do not pose unacceptable risk to populations of plants, fish and aquatic invertebrates, or birds and mammals.

6.6.5.2 Remedial Action Subsite 2

The remediated portion of RASS 2 still contains high concentrations of some metals in soil. No special status plant species are found in this portion of RASS 2; therefore, risk to populations of plants from residual concentrations of metals is not a concern. RASS 2 only contains soil locations and no evidence exists that marsh surface soils are migrating; as a result, risk to fish or aquatic invertebrates was not evaluated. No unacceptable risk to populations of birds and mammals was shown for any location in the remediated areas of RASS 2.

6.6.5.3 Remedial Action Subsite 3

Concentrations of metals remaining in the remediated portion or RASS 3 were not found to pose unacceptable risk to populations of plants or birds and mammals. Potential migration of metals, especially zinc, from contaminated sediment and soil locations along Nichols Creek into the RASS 3 pond and RASS 1 wetland is a concern. This transport pathway is probably the historical route of contaminant migration that caused the high levels of metals in Unit 10 and Unit 11 that do pose an unacceptable risk to fish and invertebrates.

6.6.5.4 Remedial Action Subsite 4

No special status plants are found in the remediated portions of RASS 4; this area is dominated by nonnative grasses that are typical of disturbed areas. RASS 4 is not considered to pose an unacceptable risk to populations of upland or wetland plants. The remediated areas in RASS 4 are upland locations; as a result, risk to fish and invertebrates was not considered. No unacceptable risk to populations of birds or mammals was indicated based on residual concentrations of metals in RASS 4.

6.6.6 Conclusions of the Baseline Ecological Risk Assessment

The following conclusions were based on the characterization of risk to plants, fish and aquatic invertebrates, and birds and mammals for RASSs 1 through 4:

- Concentrations of metals in soil and sediment at selected areas of the site may pose unacceptable risk to individual plants for some species; however, unacceptable risk is not indicated at the population level for any wetland or upland plant species at the Litigation Area. During the site inspection tour in July 2001, an area of distressed vegetation was observed in RASS 1 along the berm separating the Litigation Area from GCC and Honeywell, Inc. property (Appendix B). The Navy did not assess possible causal factors and risk implications for the distressed vegetation in the remediated area of RASS 1 as part of the BERA. The Navy will address these concerns in a future investigation (Section 10.0).

- Population-level effects to fish and aquatic invertebrates from exposure to DDTs, PCBs, and Aroclors in sediment at the Litigation Area are not indicated. Elevated concentrations of metals in sediment and surface water may pose some unacceptable risk to populations of fish and aquatic invertebrates at selected locations in the main reach (Unit 10) and western arm (Unit 11) of Lost Slough (Figure 93). High metal concentrations were detected in surface water and sediment samples from the mosquito ditches in Unit 7. Results of the ditch-profile studies suggest the potential for mobilization and transport of contaminated sediment into Lost Slough. In addition, migration of contaminants from RASS 3 to RASS 1 is a potential concern. Mobilization and increased bioavailability of metals from on-site sources (such as Nichols Creek and off-site sources) may present an ongoing risk to fish and aquatic invertebrates in the southern portion of RASS 1. Section 10.0 discusses the Navy's approach to addressing this risk.

- Population-level effects to birds and mammals from exposure to DDTs and PCBs and Aroclors in sediment or soil and prey at the Litigation Area are not indicated based on the analysis of existing data. However, some concern exists with respect to potential PCB data gaps in areas along the northern margin of RASS 3 bordering the SPTC railroad property and along Nichols Creek downstream of the CPC property. The Navy will address this concern in a future investigation (Section 10.0). Some unacceptable population-level risk from exposure to metals may exist for the California Black Rail (risk driver is zinc) and Suisun Song Sparrow (risk driver is selenium) along areas of the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7 (Figure 94). Some unacceptable risk is indicated for individual salt marsh harvest mice from arsenic at a small number of locations in Unit 6; however, unacceptable risk of population-level effects is not indicated for the harvest mouse. Risk estimates for the salt marsh harvest mouse at point locations were based on maximum concentrations in 6-inch vertical composite cores. The Navy determined that the exposure potential for the salt marsh harvest mouse was low based on a detailed analysis of vertical profiles. The analysis showed higher contaminant concentrations are buried several inches below cleaner soil that has accreted on the marsh surface. The dense layer of vegetation on the marsh surface serves as a barrier, thereby limiting the lateral migration of contaminants. The Navy has concluded that the negative effects of additional remediation over a wide area of the southeastern marsh surface in RASS 1 would outweigh any potential reduction in risk that could be obtained.

7.0 ASSESSMENT

The assessment of protectiveness was based on the findings described in Section 6.0 and answered the following questions:

- Is the remedy functioning as intended by the decision documents?
- Are the assumptions used at the time of the remedy selection still valid?
- Has any other information come to light that could call into question the protectiveness of the remedy?

At the Litigation Area, the remedy included active remediation of a portion of each RASS and passive remediation and monitoring of contaminants left in place in the remaining area of each RASS. The active remediation, passive remediation, and monitoring components of the remedy were reviewed and discussed separately, as appropriate.

7.1 IS THE REMEDY FUNCTIONING AS INTENDED BY THE DECISION DOCUMENTS?

This part of the assessment considers the performance of the remedial action, including whether performance standards and requirements of the decision documents were met, whether any early indicators of remedy failure exist, operations and maintenance costs, adequacy of access controls, and whether any opportunities for optimization exist.

7.1.1 Remedial Action Performance

The two components of the remedy are discussed separately: (1) active remediation, including excavation and removal of most contaminated soil in active areas of each RASS, followed by revegetation and (2) passive remediation and monitoring of contaminants left in place. The Navy fully implemented the remedial actions identified in the RAP and ROD.

7.1.1.1 Active Remediation

The remedial actions generally met cleanup criteria in the active areas. Cleanup criteria were met based on the remedial action sampling approach that consisted of vertical and lateral delineation throughout the remedial action area and excavation of grids that failed to meet criteria (listed in Section 3.3). This success was confirmed by concentrations measured in these areas immediately after remediation (Tables 3, 5, 7, and 9). However, a few locations in RASS 3 sampled immediately after remediation

exceeded SARAC for cadmium and zinc (Table 7); this occurrence is not surprising given the high variability in this type of chemical data.

With the exception of the active area in RASS 3, the actively remediated areas have not been recontaminated based on results from the 5 years of monitoring; concentrations in the active areas have remained relatively constant (Appendix D). In RASS 3, a continuing upgradient source may still exist at the CPC facility, and soil erosion has been visually identified in areas of high concentrations of chemicals along the creekbed that may be causing migration of contaminated soil into the active area (Appendix E).

With the exception of the high concentrations of zinc remaining in the Nichols Creek area of RASS 3, the cleaned up active areas are protective of ecological and human receptors (Appendices F and G). The high concentrations of zinc in Nichols Creek sediments may migrate downstream to the wetland habitat and pose a risk to populations of aquatic invertebrates and fish.

The Navy is concerned about an area of distressed vegetation along the berm separating the GCC facility from the remediated portion of RASS 1. The area of distressed vegetation was observed on the site inspection tour in July 2001 and was still visible during a subsequent site visit in November 2001 (Appendix B-5). This area was excavated and backfilled with clean soil during the original remediation activities and restored with marsh vegetation, which survived through the 5 years of monitoring. The cause of the distressed vegetation is not known; however, distressed vegetation could be an indication of chemical contaminants migrating into this area from neighboring sources. The Navy proposes further investigation of this area (Section 10.0).

The Navy and the regulatory agencies observed semilithified or ashy soil in the central portion of RASS 4 during the site inspection tour in July 2001. Laboratory analysis is required to characterize the soil. The Navy proposes further investigation of the soil (Section 10.0).

Revegetation and site restoration efforts were quite successful in most areas, with many areas exceeding success criteria after 5 years (Table 20). The wetland restoration efforts in RASS 1 were particularly successful. However, there were a few minor exceptions where revegetation efforts did not meet success criteria, including several plant associations in RASS 2 and the coyote brush survival in RASS 4. Because of hydrologic conditions, soil quality, or the presence of invasive species in these areas, success criteria may never be met at these locations, even with additional effort. In August 2001, a fire in RASS 4 burned coyote brush that was planted during the restoration and nonnative grasses that had invaded the site. In January 2002, many of the coyote brushes were resprouting.

7.1.1.2 Passive Remediation and Monitoring of Contaminants Left in Place

The Navy fulfilled the monitoring requirements identified in the RAP and ROD, completing preremediation, during remediation, and after remediation monitoring. The monitoring plan called for intensive monitoring for 5 years, followed by less intensive monitoring every 5 years after that (Lee and others 1989a). The monitoring program provided data that allow for a better characterization of risk and the potential for uncontrolled migration of contaminants at the site. The Navy was also very responsive to agency concerns and conducted many special studies to address issues that were not being addressed under the annual monitoring program.

However, the monitoring program had very general objectives and did not provide any clear action levels for further remediation or cessation of monitoring. The original monitoring design did not provide sufficient information to address concerns about the biased nature of the sampling design, lack of sampling in sloughs and ditches, the high variability in chemistry data, and the artificial distinction between passive and monitoring areas. The redesign of the monitoring program addressed these concerns and focused the monitoring on the scale of the spatial unit; this redesign was performed in conjunction with the regulatory and trustee agencies, with the knowledge that changing the program would limit the ability to make some kinds of pre- and postremediation comparisons (Appendix D).

Contamination at levels exceeding cleanup criteria still persists in the unremediated portions of the site. In addition, new areas of high metals contamination in the southwestern portion of RASS 1 (Unit 11 slough) were discovered during post-remediation monitoring. The Navy evaluated the success of passive remediation using a screening-level HHRA (Appendix F) and a BERA (Appendix G) to assess risk from remaining levels of contamination. Results of these assessments indicate some ecological risks remain at the Litigation Area. Therefore, passive remediation did not eliminate ecological risk completely at the site. These assessments are summarized in Sections 6.5 and 6.6, respectively. Risk to human health is low based on adequate access controls. However, recent evidence of trespassers at RASS 4 indicates some additional actions may be necessary to secure the site (Section 10.3).

7.1.1.3 Were Remedial Action Objectives Met?

Specific remedial action objectives were identified in the FS (Cullinane and others 1988); the success of the remedy in meeting these objectives is summarized below.

1. **Prevent Biota from Contacting Contaminated Soils that would Threaten Them:** The active removal of the most contaminated soils from each RASS successfully reduced the risk of exposure for biota at the site. However, the high levels of metals remaining at some portions of the site, particularly the sloughs and ditches in RASS 1, present an unacceptable risk that indicates that this objective was not fully met for biota in some unremediated portions of the site. Ecological receptors at some risk include fish and invertebrates, Black Rails, Suisun Song Sparrows, and salt marsh harvest mice.

2. **Prevent Resuspension in Surface Water and Air and Redistribution of the Contaminated Sediments and Soils that would Threaten the Flora and Fauna in the Area:** Contaminants on the marsh surface are slowly getting buried by cleaner sediments, and risk is being naturally reduced. For example, salt marsh harvest mice and Black Rails are not likely to be exposed to contaminants buried under 3 inches of cleaner sediment on the marsh surface. In addition, it is not likely that significant migration of contaminants on the marsh surface exists because of the presence of a dense vegetative mat. Uncontrolled migration of metals contamination in the ditches and sloughs poses a greater risk to fish and invertebrates, especially if metals become more bioavailable when mobilized in the oxidized sediment layer or resuspended or dissolved in surface water. Based on the evaluation of contaminant migration described in Appendix E, contaminants in the marsh surface soils are slowly being reburied by cleaner soils, and little indication of uncontrolled migration exists, while contaminant concentrations in the ditch and slough bottoms are consistent with localized patterns of erosion and accumulation. Migration of contaminants is of concern in Units 7, 10, 11, and 13.

3. **Minimize Disturbance to the Wetlands Consistent with Long-term Protection of Flora and Fauna:** The decision to leave contaminants in place in RASSs 1 and 2 was based in large part on minimizing disturbance to critical wetland habitat; the tradeoff between habitat destruction and ecological risk from contaminants is a difficult one to quantify. Based on results of the BERA (Appendix G), the decision to leave contaminants in place on the marsh surface was protective. However, contaminants left in place in Nichols Creek or the ditches and sloughs in the southern portion of RASS 1 may present some unacceptable risk to fish, invertebrates, and the Black Rail, especially when mobilized.

4. **Prevent Migration of Contaminants in Groundwater:** Contaminants occur in some groundwater wells at concentrations of concern; however, studies indicate that groundwater movement through the marsh is very slow and migration of contaminants in groundwater at the site is not of high concern. This objective was met by the removal of the most contaminated soils; subsequent monitoring of groundwater showed decreased concentrations of metals. Some groundwater concerns remain, including the presence of extremely high concentrations of metals in groundwater at neighboring off-site chemical facilities that are upgradient of the Litigation Area (Appendix E).

In addition, numeric cleanup criteria were established for the active remediation areas of each RASS, as defined in Section 3.3. Cleanup criteria were met in the active remediation areas of RASSs 1, 2, and 4 (Tables 3, 5, and 9) and were generally met in the active area of RASS 3. However, some locations in RASS 3 had cadmium and zinc concentrations immediately after remediation (Table 7) that were higher than SARAC.

7.1.2 Operation and Maintenance

The remedial actions were fully implemented, as described in the RAP. As part of the remedy, the Navy also completed the required preremediation, during remediation, and postremediation monitoring. The following table provides a summary of the costs the Navy has incurred (after the ROD) to implement and maintain the remedy, as described in the ROD. This summary does not include the costs for site investigation and legal efforts before signing the ROD, nor does it include the costs to conduct the five-year review assessment. The Navy has spent almost $19 million to date on implementation and maintenance of the remedy, as detailed in the following table.

Activity	Costs ($)
Remedial Action	
Remedial Design	500,731
Implementation (approximate)	10,000,000
Oversight	529,812
Monitoring	
Preremediation (baseline conditions)	2,496,572
Year 1	947,106
Year 2	947,106
Year 3	854,492
Year 4	594,110
Year 5	652,804
Other Studies	
Qualitative Ecological Assessment	1,242,722
Total Cost (approximate)	18,765,000

7.1.3 Access Controls

The Litigation Area is currently used by the Navy as a buffer zone to ensure security for military operations. Most of the Litigation Area lies within the “explosive arc” safety zone that is used to safeguard human life during the loading of ammunitions onto ships docked at nearby piers in the Tidal Area. Access to the Litigation Area is limited to those personnel approved by the Navy and access is not allowed to most personnel during ship loading events. Regular security patrols and intermittent fencing in areas near roads limit access by trespassers. No buildings exist on the site (other than a portable trailer used by environmental contractors located just east of RASS 3); the one access road into RASS 3 is

blocked and gated with a chain-link fence. The site is traversed by several railroad tracks; the railroads own right-of-ways that extend 50 feet on either side of the track.

Authorized visitors to the site include environmental contractors, mosquito abatement workers, and security patrols. During the site inspection tour in July 2001, the Navy and the agencies observed evidence of trespass at RASS 4 (Section 6.1). Access controls, when they are fully implemented, are considered sufficient to limit human access to the site to these authorized individuals. Because of the potential human health risk at the site, especially from arsenic, the Navy will ensure that all individuals authorized to enter the site understand the environmental hazards and that unauthorized trespass is prevented by more complete and secure fencing and regular patrols.

The Navy acknowledges that access controls are currently insufficient, especially at RASS 4, and will take steps to remedy the situation. Section 10.3 discusses the specific steps that the Navy will implement.

7.1.4 Opportunities for Optimization

The Navy cannot ensure long-term protectiveness of the remedy if there are still ongoing off-site sources of contamination to the site. The optimal approach is to address upgradient sources or areas before downgradient areas to minimize the potential for recontamination of remediated areas. The overall remedy should be optimized by ensuring that neighboring sources have been addressed; ongoing contamination of the site by off-site sources should be fully addressed before the Navy completes any additional actions.

The Navy will consider the ecological value of the wetland (marsh surface and slough habitats) when evaluating any additional actions in RASS 1; specifically, the short- and long-term impacts on ecological health and special status species of no-action and various remedial action alternatives will be considered.

The Navy conducted many additional studies during the monitoring program to address agency concerns; consequently, operation and maintenance costs for monitoring were higher than anticipated. The monitoring program met its objectives; however, the monitoring objectives were very general and did not include specific triggers or criteria prompting additional action or cessation of monitoring. Any future monitoring should be more tightly focused on specific areas and parameters at the site and should include specific objectives and triggers for additional action.

7.1.5 Indicators of Remedy Failure

Neither the ROD nor the monitoring program clearly identified triggers for additional remediation or cessation of monitoring. Success of the remedy was evaluated in the context of whether the remedy fulfilled requirements of the ROD, whether cleanup values were attained, and whether the remedy is protective of human health and the environment. The Navy complied with the requirements of the ROD, completed the proposed remedial actions, and generally attained the cleanup values in the remediated areas of the site.

The screening-level HHRA conducted as part of this five-year review identified little risk for workers exposed to remaining site contaminants during periodic visits under current site conditions (Section 6.5 and Appendix F). If land use were to change to an industrial or residential scenario, significant environmental hazards would exist that would need to be addressed; this future land-use scenario is unlikely in the wetland part of the site. Access controls need to be improved to ensure that trespassers do not have easy access to the sites. The Navy's plans for addressing this issue are discussed in Section 10.3.

The QEA (PRC 1997c) provided the first evidence that contaminants left in place may pose some risk to ecological receptors. A weight-of-evidence approach utilized in the BERA conducted during this review confirmed that some areas of the site pose some unacceptable risk to ecological receptors, particularly to fish and invertebrates, Black Rail, Suisun Song Sparrow, and salt marsh harvest mice (Section 6.6 and Appendix G)

The evaluation of neighboring facilities acting as ongoing sources indicates that these neighbors have either not cleaned up the original sources, as described in the ROD and consent decrees, or have new environmental problems that may be affecting the Litigation Area (Section 6.4 and Appendix E). High concentrations of metals in soil and groundwater at the CPC facility and the GCC facility have a high potential for off-site migration toward the Litigation Area. Observations of railcar spills and distressed vegetation in RASS 1 made during the site inspection tour provided additional evidence of ongoing sources that reduce the protectiveness of the remedy. Recontamination of the site by ongoing off-site sources may therefore affect the performance of the remedy.

Finally, special studies conducted during the monitoring program to address concerns about migration of contaminants in sediment, surface water, and groundwater indicate that uncontrolled migration of metals may exist in some areas, particularly in the ditches and sloughs of RASS 1 and in the Nichols Creek area

in RASS 3 (Appendix E). This on-site migration and resulting exposure of aquatic receptors to metals contamination may affect the performance of the remedy.

7.2 ARE THE ASSUMPTIONS USED AT THE TIME OF THE REMEDY SELECTION STILL VALID?

This part of the assessment evaluated the validity of the assumptions used at the time of the remedy. Issues considered included changes in ARARs, standards, and risk assessment guidance; changes in land use; newly identified contaminants or sources; assumptions about human health and ecological exposure pathways, receptors, or toxicity; and assumptions about physical site conditions that may affect the protectiveness of the remedy.

It should be noted that Naval Weapons Station SBD Concord was not an NPL site at the time of remedy selection, and limited agency input on the remedy was received from the regulatory and trustee agencies at the time of remedy selection and design.

7.2.1 Changes in Applicable and Relevant or Appropriate Requirements, Standards, and To Be Considereds

Changes in ARARS, standards, and TBCs were identified in Section 6.2. Several threatened or endangered species that were not known to be at the site at the time of remedy selection have since been observed or considered likely to occur at the Litigation Area; other species identified at the time of remedy selection are now thought not to reside at the site. New water quality criteria have been promulgated since the time of remedy selection, and the Navy has agreed to evaluate surface water quality using the standards identified in Tables 10A and 10B.

The four remedial action objectives, stated as general environmental goals, described in Section 3.3 are still considered valid. The numeric cleanup criteria (TTLC and STLC) identified in the RAP would not likely be considered valid today, since they are not risk based numbers. However, the assessment of remaining risk in remediated areas indicates that numeric cleanup criteria were protective of human health and the environment. If additional remedial actions are considered, the cleanup criteria should be reevaluated.

Current ERA guidance (EPA 1997a) for CERCLA sites was not available at the time of remedy selection, and a HHRA was not performed at that time. The Navy agreed to conduct a screening-level HHRA and a BERA during the five-year review to reconsider risk at the site (Appendices F and G).

EPA recently released guidance on five-year reviews (EPA 2001), and the Navy recently released a policy statement on five-year reviews (Navy 2001). While these documents are not relevant to the ARARs selected at the time of the remedy, they do provide guidance on how to evaluate the protectiveness of the remedy. Considering their release dates, this five-year review was consistent with available guidance.

The Navy is evaluating whether the new Small Business Liability Relief and Brownfields Revitalization Act (42 U.S.C. Section 9607[q]), signed by the President on January 11, 2002, affects the Navy's liability for contamination from off-site contiguous properties.

7.2.2 Changes in Land Use

The assumptions about land use at the Litigation Area were not explicitly stated in the decision documents. However, since the Navy purchased these contaminated properties from neighboring landowners with the expressed purpose of using the land as a buffer zone for military ordinance activities, it can be assumed that the assumptions about land use have not changed. No significant changes in land use around the Litigation Area have occurred since the time of remedy selection based on review of aerial photos (Figure 9). Land use is not expected to change in the future.

7.2.3 Newly Identified Contaminants or Sources

The RI did not adequately characterize either the spatial distribution of metals contamination or the presence of other kinds of contaminants such as organic chemicals. Additional sampling conducted after remedy selection (under the monitoring program and during the QEA) has fully characterized nature and extent of contamination across the site.

The spatial extent of metals contamination is now known to be greater than was known at the time of remedy selection; that is, the six metals are found in a larger area of the marsh surface, sloughs, and ditches in RASS 1 than was known at the time of remedy selection. Organic contamination at the site is limited and does not pose an unacceptable risk to human or ecological receptors; therefore, the assumption during the RI that the six metals (arsenic, cadmium, copper, lead, selenium, and zinc) are the risk drivers at the site is still valid.

Additional evaluation conducted since the remedy selection has also identified the neighboring chemical companies as potential ongoing offsite sources to the Litigation Area (Appendix E). In the ROD, the Navy assumed that neighboring sources would be remediated to the extent that they would not affect Navy property; some of these neighboring sources have not been removed and may still be contributing contaminants to the Litigation Area. Neighboring sources are discussed further in Appendix E.

The five-year review process, including the site tour and discussions with the regulatory and trustee agencies, identified some data gaps related to site characterization and ongoing sources. In particular, the spatial extent of PCBs in RASS 3 was not fully characterized and semilithified soil observed in RASS 4 has not been characterized. Section 10.2 discusses the Navy's approach to addressing these data gaps.

7.2.4 Assumptions about Human Health Exposure Pathways, Receptors, or Toxicity

A HHRA was not conducted at the time of the remedy, and few assumptions about human health exposure were provided in the RI (Lee and others 1986, 1988a). The approach to evaluating or addressing human health risk used at the time of the remedy would not be valid today, since most RIs conducted under CERCLA include a screening-level HHRA.

The screening-level HHRA conducted as part of the five-year review used the latest guidance and methodology to evaluate risk to human health under a variety of scenarios. The screening-level HHRA was based on assumptions about access controls in RASS 4 that may not have been entirely accurate. Recent observations indicate that trespassers have gained access to RASS 4; however, the Navy will take steps to ensure that RASS 4 is secured to prevent trespass.

7.2.5 Assumptions about Ecological Exposure Pathways, Receptors, or Toxicity

Assumptions about ecological exposure were provided in the RI (Lee and others 1988a) and biological assessment (O'Neill 1988). The pathways, receptors, and toxicity identified in these documents would still be considered valid today; however, an ERA was not conducted at the time of the remedy selection. The approach to evaluating ecological risk used at the time of the remedy would not be valid today, since most RIs conducted under CERCLA include an ERA.

The QEA conducted from 1995 to 1997 (PRC 1997c) and the BERA conducted as part of the five-year review have developed new assumptions about ecological exposure pathways, receptors, and toxicity at the site (Appendix G). The BERA, which was conducted in accordance with current guidance (EPA 1997a), is considered sufficient to assess ecological risk from remaining contaminants at the site and to provide recommendations about protection of ecological receptors. The BERA provides a more focused assessment of risk at the site.

7.2.6 Assumptions about Physical Site Conditions

The FS and RAP included many assumptions and descriptions of physical characteristics of the site and the potential for contamination migration (Cullinane and others 1988; Navy 1989a). These documents discussed concerns about migration of contaminants in Nichols Creek, ditches, and sloughs that would still be considered valid; however, special studies conducted during the monitoring program have provided essential information for validating assumptions about contaminant migration and identifying areas of high concern.

7.3 HAS ANY OTHER INFORMATION COME TO LIGHT THAT COULD CALL INTO QUESTION THE PROTECTIVENESS OF THE REMEDY?

This part of the assessment considers any other factor that may call into question the protectiveness of the remedy, including whether human health and ecological risks are being addressed, whether this is uncontrolled migration, and whether ongoing sources exist. The 5 years of monitoring and special studies have provided new information that was used to reevaluate protectiveness of the remedy.

7.3.1 Human Health Risk

New information on potential risk to human health does not call into question the protectiveness of the remedy. As stated in Section 6.5, no unacceptable risk to human health exists that requires additional remedial action to address under current land use. If land use were to change to a residential or industrial scenario, environmental hazards would need to be reevaluated. Because of recent observations that trespassers have gained access to RASS 4, the Navy will improve access controls to ensure protectiveness of the remedy.

7.3.2 Ecological Risk

Better estimates of ecological risk derived from the BERA indicate that the active remediation was successful in reducing risk; however, the passive remediation portion of the remedy was not completely protective of receptors in the ditches and sloughs in the most contaminated portions of RASS 1. Multiple lines of evidence were evaluated in the BERA to assess risk to a variety of receptors; risk characterization summaries for each line of evidence and overall conclusions are presented in Tables 107, 108, 109, 111, and 112. The site is not considered to pose an unacceptable risk to populations of plants. High levels of metals in sediment and surface water in ditches and sloughs in RASS 1 pose some unacceptable risk to fish and invertebrates, the Black Rail, and the Suisun Song Sparrow. While much of the metals contamination is buried in anoxic sediments and is not likely to be bioavailable, some risk is indicated

when metals are periodically mobilized and made more bioavailable in these dynamic systems. Some unacceptable risk to individual salt marsh harvest mice may be present from arsenic at some locations in the marsh surface in Unit 6; however, the risk assessment used sample data from the 0- to 6-inch horizon, and the highest concentrations of arsenic are at 3 to 5 inches bgs and are being buried by cleaner sediment. Salt marsh harvest mice are not expected to be exposed to the highest concentrations observed.

7.3.3 Uncontrolled Migration

Uncontrolled migration of metals in sediments may exist in ditch and slough bottoms in the southern portion of RASS 1 that call into question the protectiveness of the remedy since mobility and subsequent bioavailability of metals poses an unacceptable risk to fish and invertebrates, and Black Rails, in the ditches and slough in Units 7, 10, and 11. In addition, uncontrolled erosion and migration of contaminated soil in Nichols Creek (Unit 13) may be affecting the wetland in RASS 1. Metals contamination in soil and sediment is assumed to become more bioavailable when mobilized, since sediments are oxidized and metals are released into the dissolved phase.

Off-site neighboring sources may be affecting the Litigation Area through uncontrolled migration. In particular, high concentrations of metals in groundwater in perched zone at CPC may be hydrologically connected to surface waters in Nichols Creek

7.3.4 Ongoing Off-site and On-site Sources

Neighboring off-site sources have not all been removed, as required in the ROD and consent decrees. In addition, new off-site sources such as railcar spills of aluminum-based powder have been discovered. A review of regulatory agency files indicates that the CPC facility and the GCC facility have significant contamination, with a high potential for off-site migration. Migration of contaminated groundwater and surface runoff are of highest concern. Since these sites are upgradient from the Litigation Area and may be impacting the site, these ongoing sources call into question the protectiveness of the remedial actions conducted to date.

The Navy doubts its ability to meet ARARs, protect human health and the environment, and provide long-term protection for the site if there are significant ongoing off-site sources of contamination. Long-term protectiveness requires that both off-site sources and on-site areas that pose a risk are addressed. Therefore, long-term protectiveness requires the participation of adjoining property owners and regulatory agencies to address off-site concerns.

On-site sources include areas that have high metals contamination remaining that pose some unacceptable risk or areas of high metals contamination that may have uncontrolled migration. The ditches and sloughs in the southern portion of RASS 1 pose an unacceptable risk to some ecological receptors when metals are bioavailable; the ditches and sloughs are also an area of uncontrolled migration. The Nichols Creek area in RASS 3 is an area of uncontrolled soil erosion and potential surface water and groundwater migration.

8.0 DEFICIENCIES

This section briefly summarizes deficiencies in the remedy, data gaps, and remaining concerns at the site.

8.1 DEFICIENCIES OF THE REMEDY

This section describes deficiencies of the remedy that currently prevent the response action from being protective or have the potential to do so in the future. The major deficiencies of the remedy are summarized in the table below.

Deficiencies of the Remedy	Affects Protectiveness?
Presence of Ongoing Off-Site Sources: Neighboring properties may be ongoing upgradient sources of contaminants to the Litigation Area. Given the evidence suggesting ongoing off-site sources, the Navy doubts its ability to protect human health and the environment, meet ARARs, or provide long-term protectiveness of the site. The potentially responsible parties should address these off-site sources to ensure protectiveness of the remedy. The following potential off-site sources are of concern: • Area of distressed vegetation in remedial action subsite (RASS) 1: During the sites inspection tour in July 2001, the Navy and the agencies observed an area of distressed and dead vegetation in the remediated portion of RASS 1 along the berm separating the General Chemical/Honeywell, Inc. facilities from Navy property. It is not yet known whether this distressed vegetation is caused by chemical contamination from the chemical companies. • Groundwater-surface water interactions near Chemical Pigment Company (CPC): Groundwater within a perched aquifer beneath CPC is contaminated with high concentrations of zinc and, to a lesser degree, copper, and lead. Because this perched aquifer may be in hydraulic communication with Nichols Creek, discharge from the aquifer may significantly affect surface water quality in Nichols Creek and the Litigation Area marsh. Dissolved metals in groundwater that discharge to Nichols Creek are expected to discharge to the Litigation Area marsh, rather than become impounded in the RASS 3 pond. • Railcar spills between RASSs 1 and 3: During the site inspection tour in July 2001 and subsequent visits, the Navy and the agencies observed evidence of repeated spills of white aluminum-based powder from railcars parked on the ATSF railspur leading into the GCC facility.	Yes
Uncontrolled Soil Erosion in RASS 3: Metals detected at high concentrations in soil or sediment samples from some locations in RASS 3 remain a potential on-site source to the wetland in RASS 1. Uncontrolled migration from soil erosion along Nichols Creek in RASS 3 may continue to mobilize and spread contaminants into the wetland habitat in RASS 1. In addition, metals in soil and sediment in two major erosional areas within the railroad right-of-ways adjacent to RASS 3 are significant off-site sources and are not the responsibility of the Navy.	Yes
Uncontrolled Migration and Ecological Risk in Selected Ditches and Sloughs in Southern RASS 1: High concentrations and uncontrolled migration of metals in ditches and sloughs in the southern portion of RASS 1 may pose an unacceptable risk to ecological receptors because metals become more bioavailable when mobilized. As a result, metals in sediment from some of the ditches and sloughs in RASS 1 (Units 7, 10, and 11) remain a significant on-site source that poses some unacceptable risk to fish and aquatic invertebrates and the California Black Rail.	Yes
Inadequate Access Controls in RASS 4: Observations made during the site inspection tour in July 2001 indicate that trespassers have gained access to RASS 4. The site is not fenced on the north side, locks on gates have been broken open, and evidence of motorcycle tracks and dumping within RASS 4 was observed.	Yes

8.2 DATA GAPS

This section briefly summarizes the data gaps identified by the Navy during the five-year review process or during risk management meetings. The data gaps will be addressed during additional focused investigations as described in Section 10.2. The following data gaps were identified:

- **Distressed Vegetation in RASS 1:** The cause of distressed vegetation in the RASS 1 remediated area along the border of the chemical companies is not known; however, it could be related to contaminant migration from the waste lagoons or contaminated groundwater at the GCC or Honeywell, Inc. facilities. The preliminary file review documented high concentrations of metals and low pH in groundwater at the General Chemical facility. The Navy recommends sampling the area of distressed vegetation and nearby unimpacted areas for metals and pH to determine whether chemistry is the underlying cause of the distressed vegetation.

- **Groundwater-Surface Water Interactions at CPC Border:** The extent of groundwater-surface water interaction at the Navy property and CPC facility border is not known. The preliminary file review documented extremely high contaminant concentrations in groundwater at CPC and the presence of a perched aquifer. The Navy recommends investigating the groundwater-surface water interaction in this area to evaluate the likelihood that CPC facility groundwater is adversely affecting Nichols Creek and Navy property.

- **Litigation Area Groundwater Well Sampling:** The groundwater wells at the Litigation Area have not been sampled since 1996, representing a gap in the understanding of current groundwater conditions at the site.

- **RASS 3 PCB Sampling:** Although PCBs were detected infrequently and not considered to present an ecological or human health risk in RASS 3, spatial data gaps exist in the characterization of PCB distributions in portions of RASS 3. The Navy recommends additional focused sampling of the spatial distribution of PCBs in RASS 3 to reduce uncertainty.

- **RASS 4 Semilithified Soil Sampling:** During the site inspection tour in July 2001, the Navy and the agencies observed semilithified soil in the area of motorcycle tracks in RASS 4. The Navy recommends analyzing this soil to determine its chemical composition.

9.0 PROTECTIVENESS STATEMENTS

Protectiveness was evaluated in two ways. The remedy was not considered protective if (1) an immediate threat is present or (2) migration of contaminants is uncontrolled. The following sections provide protectiveness statements for each RASS at the Litigation Area.

9.1 PROTECTIVENESS STATEMENT FOR REMEDIAL ACTION SUBSITE 1

The remedy at RASS 1 is not protective of the environment. The active remediation of approximately 9.0 acres in RASS 1 is protective of human health and the environment and meets the requirements of the ROD. However, the passive remediation and monitoring component of the RASS 1 remedy is not protective because uncontrolled migration of contaminants exists in the ditches and sloughs in the southern portion of RASS 1 (Units 7, 10, and 11) and some unacceptable risk exists to fish, aquatic invertebrates, and Black Rails from contaminants remaining in these spatial units. Some unacceptable risk is also indicated for salt marsh harvest mice from arsenic at four locations in Unit 6; however, little indication exists of uncontrolled migration of contaminants from the marsh surface, and contaminated sediments are found primarily at 4 to 5 inches bgs and are slowly being buried by cleaner sediment on the marsh surface. No unacceptable risk exists to human receptors from contaminants in RASS 1 under current land use.

9.2 PROTECTIVENESS STATEMENT FOR REMEDIAL ACTION SUBSITE 2

The remedy at RASS 2 is protective of human health and the environment. The active remediation of approximately 4.1 acres in RASS 2 was protective of human health and the environment and met the requirements of the ROD. In addition, the passive remediation and monitoring components of the RASS 2 remedy were also protective, since no indication exists of uncontrolled migration of contaminants or unacceptable risk to human or ecological receptors.

9.3 PROTECTIVENESS STATEMENT FOR REMEDIAL ACTION SUBSITE 3

The remedy at RASS 3 is not protective of the environment. The active remediation of approximately 4.66 acres in RASS 3 met cleanup criteria required by the ROD at most locations; however, some locations had concentrations of zinc and cadmium measured after the remediation that exceeded cleanup criteria. In addition, the passive remediation and monitoring components of the RASS 3 remedy are not protective, since uncontrolled migration of contaminants still exists in Nichols Creek. If these contaminants migrate to Lost Slough, they may pose an unacceptable risk to ecological receptors in the

southern portion of RASS 1. No unacceptable risk exists to human receptors from remaining contaminants in RASS 3 under current land use.

Contaminants on the neighboring chemical company (CPC) and railroad properties may represent uncontrolled off-site sources that may be affecting RASS 3; these potential off-site sources should be addressed before any additional actions are taken at RASS 3.

9.4 PROTECTIVENESS STATEMENT FOR REMEDIAL ACTION SUBSITE 4

The remedy at RASS 4 is protective of human health and the environment. The active remediation of approximately 0.87 acre in RASS 4 is protective of human health and the environment and met the requirements of the ROD. In addition, the passive remediation and monitoring components of the RASS 4 remedy are also protective. No indication exists of uncontrolled migration of contaminants or no unacceptable risk remains to human or ecological receptors. The Navy plans to implement measures to improve access controls at RASS 4 to prevent trespassing and ensure protectiveness of the remedy.

10.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations include descriptions of follow-up actions needed to (1) achieve or continue to maintain protectiveness and (2) address data gaps or deficiencies identified in the five-year review. The Navy received comments from the regulatory and trustee agencies on the draft five-year periodic review assessment report and submitted responses to the comments to the agencies on February 28, 2002 (included in Appendix H). The Navy revised the preliminary recommendations included in the draft report based on agency comments and discussions with the regulatory and trustee agencies at two risk management meetings held on February 22 and March 27, 2002. Meeting minutes from the risk management meetings are included in Appendix H. The Navy issued the draft final version of the five-year report on October 23, 2002, and received comments from EPA, RWQCB, NOAA, and DTSC between December 2002 and March 2003. In their comments, EPA invoked an informal dispute over portions of the draft final version; the Navy and agencies met on March 20, 2003, to discuss the dispute (meeting minutes are included in Appendix H). The Navy submitted responses to agency comments on the draft final version of the report on April 25, 2003 (also included in Appendix H). As agreed by the regulatory agencies, the Navy decided to only issue replacement pages for the final version of the five-year report, rather than re-issuing the entire report.

The Navy acknowledges that the remedy is not fully protective of the environment in RASSs 1 and 3; however, evidence exists that the adjoining chemical company and railroad properties may be ongoing sources of contamination to RASSs 1 and 3. The Navy doubts its ability to meet ARARs, protect human health and the environment, and provide long-term protection for the site if there are significant ongoing off-site sources of contamination. Long-term protectiveness requires that both off-site sources and on-site areas that pose a risk are addressed. Therefore, long-term protectiveness requires the participation of adjoining property owners and regulatory agencies to address off-site concerns.

The Navy proposes conducting an additional investigation to further assess the significance of ongoing off-site sources; to determine the potential for the Navy's property to become re-contaminated from neighboring sources; and to resolve any on-site data gaps. The data gaps evaluation will include a file review of the status of investigations and current conditions at neighboring properties and an assessment of whether parties to the consent decrees fulfilled their obligation to control sources to prevent recontamination of Navy property. The Navy will conduct the data gaps evaluation and will work with the regulatory agencies, the adjoining property owners, and, if necessary, the U.S. Department of Justice to address significant upgradient off-site sources.

The Navy will also perform a supplemental feasibility study which will evaluate alternatives to ensure protectiveness of the remedy in downgradient portions of the site that are not currently protective; these areas include the Unit 7 mosquito ditches and Unit 11 slough in RASS 1 and Unit 13 Nichols Creek area in RASS 3.

Based on the results of the data gaps evaluation and the supplemental feasibility study, the Navy, along with regulatory and trustee agencies, will make a determination on whether remedial actions are warranted in these three areas and, if warranted, what types of actions are most feasible.

Section 10.1 discusses the Navy's general recommendations for future monitoring, Section 10.2 describes the Navy's specific plan for addressing data gaps through additional sampling, and Section 10.3 describes the Navy's plan for addressing the site, including areas that are not considered protective of human health or the environment.

10.1 RECOMMENDATIONS ON FUTURE MONITORING

With 5 years of post remediation monitoring now completed, sufficient monitoring information has been collected to evaluate the effectiveness of the program and to focus any future monitoring efforts. Since outstanding issues of concern still exist at the site, the Navy proposes to conduct (1) focused studies to collect additional data to address specific objectives or data gaps and (2) supplemental feasibility study to address portions of the site that are not protective of the remedy. In addition, the Navy plans to conduct focused and limited sampling to monitor conditions at the site. The monitoring program would focus on portions of the site where contaminants were left in place, including areas formerly defined as passive remediation areas and areas that are the focus of the supplemental feasibility study. The Navy will develop a new monitoring plan in collaboration with the regulatory and trustee agencies using the DQO process before conducting the next additional monitoring.

The following recommendations are made for future monitoring efforts:

- **Conduct Periodic Monitoring:** The Navy plans to conduct sampling to monitor conditions at the site in the future. In developing the monitoring plan using the DQO process, the Navy will meet with the regulatory agencies this year to determine monitoring requirements and will include the monitoring plan in the next annual amendment of the site management plan.

- **Focus Monitoring Objectives:** Any future monitoring should be designed to address specific objectives and to answer specific questions, rather than the general objectives included in the first 5 years of the monitoring program.

- **Utilize the DQO Process:** The DQO process should be used to focus future monitoring objectives.

- **Focus Monitoring Efforts on Areas of Concern:** Any future monitoring should be very focused on smaller portions of the site, where unacceptable risk or continued migration is suspected, to make best use of limited resources.

- **Clearly Identify Temporal Scope:** Any future monitoring should include more specific temporal boundaries to (1) limit the scope and length of monitoring efforts, (2) provide specific trigger levels for additional action, and (3) establish exit criteria for cessation of monitoring.

- **Link Monitoring to Risk-based Questions:** Any future monitoring should be closely tied to risk-based questions and questions about contaminant migration. Future monitoring should be designed to maximize use of existing monitoring data to detect significant changes at the site.

- **Consider Spatial Variability of Chemical Concentrations in Design:** Any future monitoring should take into account the observed variability in lateral and vertical distribution of contaminants in the design of the sampling program.

- **Clearly Identify Trigger Levels:** Any future monitoring should be closely tied to specific trigger levels for any contingency actions such as additional remediation or revision of monitoring frequency.

10.2 RECOMMENDATIONS FOR ADDITIONAL SAMPLING TO ADDRESS DATA GAPS

The Navy identified several data gaps during the five-year review process, while responding to agency comments, or based on observations made at the site during the site inspection tour. Section 8.0 describes these data gaps. Sections 10.2.1 through 10.2.5 outline the Navy's plan for collecting additional data to resolve these data gaps. The Navy and its contractors will implement the data gaps evaluation as the next step for the site. Figure 95 identifies the proposed sampling locations. The Navy prepared and submitted a draft Sampling and Analysis Plan, which included a FSP and QAPP, based on the DQO process on March 28, 2003. A revised sampling map that updates Figure 95 can be found in the Sampling and Analysis Plan.

10.2.1 Distressed Vegetation Area in RASS 1

An area of distressed vegetation was observed in the remediated area of RASS 1 along the berm separating the GCC facility and the Honeywell, Inc. alum waste ponds from the Navy's property

(Appendix B-5). A file review indicated high groundwater and soil concentrations of metals and low pH at the GCC facility, and groundwater flows west toward the Litigation Area (Appendix E). A focused investigation is required to determine whether the area of distressed vegetation is the result of chemical migration from the GCC or Honeywell, Inc. facilities into remediated marsh soils on Navy property.

The investigation will extend beyond the area of distressed vegetation to allow comparison with areas with normal (healthy) vegetation and to provide at least one sample on the margin of Suisun Bay (Figure 95). The Navy will sample soil and groundwater to evaluate the likely pathways of contaminant migration from neighboring sources. The objective of the sampling effort is to evaluate whether (1) chemical contamination is associated with the area of distressed vegetation, (2) soil and shallow groundwater in the remediated area of RASS 1 are becoming recontaminated by metals or low pH, and (3) the GCC or Honeywell facilities are the likely sources of contamination.

Based on discussions with the regulatory and trustee agencies, the Navy proposed the following tasks:

- **Task 1:** Conduct additional review of files for the GCC and Honeywell, Inc. facilities to identify COCs and available data and determine the status of ongoing investigations. If additional file reviews for the General Chemical and Honeywell, Inc. facilities indicate the potential for contaminant migration other than metals, additional chemical analyses may be conducted as part of this focused investigation.

- **Task 2:** Collect surface (0 to 0.5 foot bgs) and subsurface (1.0 to 1.5 feet bgs) soil samples at 12 locations (total of 24 samples) in an array parallel and perpendicular to the berm. Samples will be homogenized and analyzed for total metals, pH, and TOC.

- **Task 3:** Collect grab groundwater samples at nine locations collocated with the soil samples. Groundwater grab samples will be filtered and analyzed for dissolved metals and pH. Because of the slow expected recharge rate for grab groundwater samples, it may be necessary to allow the pits to fill overnight and return the following day to collect the samples. If sufficient water volume is available, unfiltered samples will also be collected and analyzed for total metals, total suspended solids, and pH.

- **Task 4:** Prepare geological cross sections based on existing data from documents obtained during the file review. The document review will include the "Technical Memorandum, Fate and Transport Evaluation: Metals in Groundwater, General Chemical Corporation Bay Point Works Facility" (Montgomery Watson 2000a) and the "Work Plan for On-site Vertical Gradient and Chemistry Evaluation, General Chemical Corporation Bay Point Works Facility" (Montgomery Watson 2000b). Evaluate stratigraphy in deeper wells at the neighboring site, if available.

10.2.2 Groundwater-Surface Water Interactions at Chemical and Pigment Company Border

Historic data show high concentrations of zinc in groundwater samples collected from wells in the center and the northwestern corner of CPC in 1998. This contamination may be flowing toward Navy property and surfacing into Nichols Creek. Groundwater in this area flows north or west based on data from wells located on Naval Weapons Station SBD Concord property. Groundwater flows to the west in the perched zone and to the northeast in the deeper sand body based on reports submitted for CPC. The extent of groundwater-surface water interaction in Nichols Creek near the CPC border is unknown. The Navy plans to conduct a focused groundwater investigation on Navy property bordering the northwestern corner of CPC property along Nichols Creek and adjacent areas in RASS 3 to evaluate the groundwater-surface water interaction in this area and the likelihood that groundwater at CPC is adversely affecting Nichols Creek or the Navy's property.

The specific objectives of this investigation are to:

1. Evaluate whether a groundwater-surface water preferential flow pathway exists at the northwestern corner of the CPC property using site lithology

2. Create geologic cross sections that extend across the site boundary onto CPC property using existing well logs from "Hydrogeologic Assessment Report for an Impoundment at 600 Nichols Road, Pittsburg, California" (Environmental Solutions 1987)

3. Install an additional monitoring well, if necessary, on Navy property near CPC to provide detailed lithologic information in the critical area between CPC and Nichols Creek and to assess contaminant concentrations migrating onto Navy property

4. Assess the recharge-discharge relationship between CPC and Nichols Creek by obtaining simultaneous surface water-groundwater elevations and elevations of the base of Nichols Creek

Based on discussions with the regulatory and trustee agencies, the Navy proposes the following tasks:

- **Task 1:** Conduct additional file review of CPC site. Obtain and review the entire hydrogeologic assessment report prepared by Environmental Solutions in 1987 as well as reports that are more recent. Obtain most recent groundwater analytical data and potentiometric elevations from CPC wells (if available). Evaluate available stratigraphy in deeper wells.

- **Task 2:** Install one new well on Navy property near border of CPC (Figure 95). Review property records to determine where the new downgradient monitoring well will be installed; the well should be as close to boundary with CPC as possible. Perform detailed lithologic logging of new wells to assess presence of perched zone or other preferential flow pathways. Sample wells during water level measurement events, when flow relationships between groundwater and surface water elevations are known.

- **Task 3:** Perform synoptic water level measurement in the complete set of wells (Navy wells and CPC wells) to define flow direction in perched zone and shallow aquifer.

- **Task 4:** Survey elevation of Nichols Creek and establish staff gauge to allow periodic measurement of surface water elevation in Nichols Creek.

To complete this work, the Navy and its contractors will require access to the CPC facility and its wells and support from DTSC. In addition, property boundaries may complicate the selection of new well location. The Navy will select the best available location on Navy property.

10.2.3 Litigation Area Groundwater Well Sampling

The Navy most recently sampled groundwater wells (11 of 22 wells) in the Litigation Area in October 1996. As a result, the Navy will sample groundwater wells to determine whether flow conditions or groundwater quality have changed since the October 1996 sampling event.

The Navy will resample existing groundwater wells in RASSs 1, 2, 3, and 4. Additional analyses will focus on metals contamination only because historic data consistently show little or no contamination by organic contaminants. Sampling can be conducted during any season; extensive historic data show no evidence of seasonality. However, sampling should be performed when tidal flooding of the marsh does not affect access to the site. Groundwater elevations will be measured in Navy wells.

Based on discussions with the regulatory and trustee agencies, the Navy proposes the following tasks:

- **Task 1:** Inspect existing groundwater wells to ensure compliance with California well standards.

- **Task 2:** Perform one round of groundwater sampling and collect unfiltered groundwater samples for metals analysis using low-flow rate sampling techniques or natural settling techniques for wells unable to support recharge rate of 0.1 liter per minute.

If groundwater samples show significantly elevated metals concentrations, additional rounds of sampling may be conducted by the Navy.

10.2.4 RASS 3 Polychlorinated Biphenyl Sampling

The BERA conducted as part of the five-year review concluded that PCBs did not pose unacceptable risk to ecological receptors. However, the BERA did acknowledge that insufficient information existed for areas within RASS 3 along the SPTC railroad track property to adequately characterize risk for this portion of the site (Figure 95). In 1996, total PCBs were detected at a concentration of 480 micrograms per kilogram (µg/kg) at a single location in RASS 3 along the SPTC railway tracks. In addition, total

PCBs were detected at concentrations ranging from 70 to 1,500 µg/kg in three confirmation samples collected within a few meters of the original location.

The Navy will conduct additional PCB analysis of soil samples collected from the northern portion of RASS 3 along the railroad track property and near the highest detected PCB concentrations to fully characterize the site. Based on discussions with the regulatory and trustee agencies, the Navy will also collect a few samples in the nearby Nichols Creek drainage area to assess potential upstream sources.

The objectives of this sampling effort are to complete the site characterization of PCBs and, if concentrations higher than 1,500 µg/kg are detected, determine whether the concentrations pose an ecological risk. Samples will be analyzed for Aroclors, rather than PCB congeners, and careful instructions will be given to the laboratory to ensure that the detection limit is less than 1,500 µg/kg.

Based on discussions with the regulatory and trustee agencies, the Navy proposes the following tasks:

- **Task 1:** Collect soil samples and analyze them for seven Aroclors (using standard Contract Laboratory Program methods); sampling locations are shown on Figure 95. Surface soil samples (0 to 0.5 foot bgs) will be collected along a corridor of about 1,800 feet, adjacent to the railroad tracks in RASS 3, and in the Nichols Creek drainage area. Surface (0 to 0.5 foot bgs) and subsurface (1 to 1.5 feet bgs) soil samples will be collected in a square array, centered on location R03SS214, where a total PCB concentration of 1,500 µg/kg was previously reported (see inset on Figure 95). All sampling locations will be on Navy property just beyond the 50-foot railway property right-of-way.

- **Task 2:** Concentrations of Aroclors in new samples will be compared with the highest existing sample that showed no ecological risk (1,500 µg/kg). If higher concentrations are found, focused food-chain modeling will be conducted to assess risk to birds and mammals.

If results of this analysis indicate that unacceptable levels of PCBs remain at selected locations along the railroad track property, the Navy will request that the railroad company evaluate the railroad property as the probable source of PCB contamination. The Navy will work with the regulatory agencies to further evaluate the risk posed by residual concentrations of PCBs on Navy property and to decide whether remedial actions are warranted.

10.2.5 RASS 4 Semilithified Soil Sampling

During the site inspection tour in July 2002, the group noticed a semilithified or ashy soil near the RASS 4 remediated area in the motorcycle tracks left by trespassers. The unusual nature of the soil raised questions about its source and chemical composition. The Navy reviewed historic aerial photographs from 1957 to 1986 to determine whether previous sampling efforts (pre- and postremediation) were

conducted in the area of semilithified soil and in other areas at the site that had a history of waste disposal. Based on this review, it was determined that the Navy had adequately sampled the portions of the site where historical activities might have resulted in the release of hazardous waste. It was not possible to determine whether previous samples of the semilithified soil were collected.

The Navy plans to collect a few samples of the semilithified soil for chemical analysis. The objective of this sampling effort is to characterize the semilithified soil observed at the site. Based on discussions with the regulatory and trustee agencies, the Navy proposes the following task: collect three samples of semilithified soil from the motorcycle track in RASS 4, and analyze the soil for metals, semivolatile organic compounds, PCBs and pesticides, TOC, and pH (Task 1).

The Navy will compare concentrations in the semilithified soil samples with existing RASS 4 soil sample concentrations to determine whether new COCs or higher concentrations of existing COCs are detected in the semilithified soil.

10.3 RECOMMENDATIONS TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT AT THE SITE

The following recommendations address areas of the site that are not fully protective. The recommendations include additional access controls to prevent trespass in RASS 4 and supplemental feasibility study to address ecological risk and contaminant migration concerns in RASSs 1 and 3. The Navy is responsible for implementing and overseeing the necessary protections for IR program sites at NWS SBD Concord, although it may reach an agreement with its Army tenant (834th Transportation Battalion) to take action for some of the necessary site controls.

The Navy is providing the general scope of the supplemental feasibility study in the five-year review; specific recommendations for additional actions will be made after the feasibility evaluation and the data gaps evaluation. The Navy and its contractors will implement the supplemental feasibility study in consultation with the regulatory and trustee agencies.

Recommendations to protect human health and the environment are described in the following sections. The following table summarizes implementation arrangements for the recommendations.

Recommendation	Party Responsible for Implementation	Implementation Schedule	Impact on Protectiveness
Maintain Measures to Control Access to RASSs 1-3 • Signage	U.S. Navy	2003	Will alleviate trespassing and significantly reduce human health exposure.
Improve and Maintain Access Controls for RASS 4 • Fencing / locked gates • Signage • Security patrols	U.S. Navy (with the cooperation of its Army tenant in the Tidal Area; e.g., security patrols)	2003-2004	Will alleviate trespassing and significantly reduce human health exposure.
Communicate Risks to Contra Costa Mosquito and Vector Abatement District (CCMVAD)	U.S. Navy	2003	Will provide CCMVAD with current information to enable them to take adequate protective measures during site visits
Conduct Supplemental Feasibility Study (FS)	U.S. Navy	2003-2004	Will identify and evaluate best alternatives for reducing risk in areas of highest concern.

10.3.1 Recommendations to Protect Human Health

Environmental conditions do not pose an unacceptable risk to human health under current land use, which includes access controls and health and safety practices of workers who have access to the site; however, evidence of trespassers in RASS 4 indicates additional measures are required to ensure that only authorized persons enter the site. The following recommendations are made to ensure continued protection of human health:

10.3.1.1 Maintain Measures to Control Access to RASSs 1-3

Existing controls should be maintained to restrict access to RASSs 1 through 3. Only authorized Navy personnel, contractors, regulatory and trustee agency representatives, and employees of CCCMVAD should be allowed to enter the area. Access to the site is dependent on permission from the Navy, and all visitors must obtain visitor passes at the NWS SBD Concord Badge and Pass Office. The Navy will post the area with signs warning of existing environmental hazards.

10.3.1.2 Improve Measures to Control Access to RASS 4

Only authorized Navy personnel, contractors, and regulatory and trustee agency representatives should be allowed to enter the area. The Navy will post the area with signs warning of trespass on Government property. The Navy will implement the following controls to prevent access to RASS 4 by unauthorized persons:

- Develop a security plan with base security personnel to ensure adequate patrols and secured locks on gates at RASS 4.
- Install a continuous fence around the north side of RASS 4 along the railroad tracks to prevent trespass on Navy property.
- Post signs warning of trespass on Government property.

10.3.1.3 Ensure Continued Worker Health and Safety

The focused HHRA was based on assumptions about health and safety practices of workers that enter the site. The Navy will meet with CCCMVAD to update the district on the nature and extent of contamination present at Litigation Area sites. No other workers or members of the public should be allowed access to the site without conducting a health and safety evaluation.

10.3.1.4 Reevaluate Human Health Risk If Land Use Were to Change

If land use were to change in the future, the environmental condition of the property should be reevaluated for the proposed use and the appropriate actions, if needed, taken to address environmental conditions on the basis of the proposed reuse.

10.3.2 Recommendations to Protect the Environment

Risk to plants and birds and mammals from contaminants in upland soils and the marsh surface was not considered unacceptable and does not warrant further action. The Navy does not believe that residual contamination in the marsh surface poses a risk that warrants additional action. This conclusion is based on the results of the BERA and the evaluation of migration potential. A few locations posed some risk to the salt marsh harvest mouse based on maximum concentrations of arsenic in 6-inch composite cores. However, vertical profiles of contaminants show that high concentrations are not found in surface soil, where mice would be exposed, but are buried under several inches of cleaner soil that has accreted on the marsh since the historic spills. The presence of a dense layer of vegetation prevents lateral contaminant migration in the area. The Navy believes that the negative impacts of additional remediation over a wide area of the southeastern marsh surface in RASS 1 would outweigh any reduction in residual risk that could be obtained. Since the marsh surface is being slowly covered with cleaner sediments, risk to the salt marsh harvest mouse should continue to decline.

Some risk exists to aquatic invertebrates and fish from metals contamination in sediment and surface water in ditches and sloughs in the southern portion of RASS 1 (especially in Units 7, 10, and 11). In addition, migration and mobility of metals in these same areas presents a risk to aquatic receptors, since

metals may become more bioavailable as they are mobilized. Contaminants were detected at higher concentrations in the Unit 7 ditches and Unit 11 slough than in the main slough (Unit 10). Sediments in Units 7 and 11 probably act as a source of contaminants to the southern reaches of the main slough. In addition, contaminated sediment in Units 7 and 11 is more amendable to remedial action and has higher concentrations than in Unit 10. Therefore, Units 7 and 11 should be addressed in supplemental feasibility study. At this time, the Navy is not recommending a supplemental feasibility study for Unit 10.

Erosion of contaminated soil along Nichols Creek presents another source of contamination to the slough in RASS 1. The Navy recommends a supplemental feasibility study to evaluate alternatives to reduce or control erosion along Nichols Creek.

The Navy proposes to analyze alternatives to increase protectiveness of the remedy at three areas of the site in Units 7, 11, (RASS 1) and 13 (Nichols Creek) (RASS 3) that will be organized into one supplemental feasibility study for the Litigation Area. The following sections describe the proposed scope of the supplemental feasibility study.

10.3.2.1 Supplemental Feasibility Study of Unit 7 Ditches (RASS 1)

One component of the supplemental feasibility study for the Litigation Area will focus on the network of mosquito ditches in Unit 7, with a special focus on the ditches that connect to Lost Slough, including four major east-west ditches and a small connector between the northernmost ditch in Unit 7 and the eastern tributary to Lost Slough, as shown on Figure 95. The ditches in Unit 7 consistently have high concentrations of metals in surface water and sediment. Ditch profiles show the proximal ends of the ditches are deeper than when originally installed, indicating erosion is occurring in some portions of the ditches. Vertical profiles of contaminants show varied patterns, indicating differential erosion and accretion of contaminated sediments within the ditches.

The overall remedial goal for Unit 7 is to reduce or eliminate mobilization of contaminated sediments from the bottoms of the mosquito ditches in Unit 7. The Navy will develop specific remedial action objectives during the supplemental feasibility stage. At a minimum, the following remedial alternatives should be evaluated in the supplemental feasibility study:

- **Alternative 1: Active Removal of Contaminated Sediment**. Physical removal of the contaminated sediments would eliminate concerns about mobilization.
    - **Alternative 1a**: Removal of all contaminated sediments in Unit 7 ditches
    - **Alternative 1b**: Removal of hotspots or isolated areas of highest contamination in Unit 7 ditches

- **Alternative 2: Active Filling**. Fill the ditches with clean fill or gravel to eliminate mobilization of ditch bottom sediments.
    - **Alternative 2a**: Fill the entire ditch system (laterally and vertically)
    - **Alternative 2b**: Fill only part of the ditch system (laterally or vertically)

- **Alternative 3: Assisted Passive Filling.** Evidence in other ditches shows that restricting groundwater flow during tidal cycles results in sediment accumulation. Restricting flow in the ditches by installing flow barriers at the junction with Lost Slough and at other selected locations should be considered to assist and speed up the natural filling process.

- **Alternative 4: Combination of Alternatives**. Some combination of removal and active or passive filling along all or part of the length of the ditches.

- **Alternative 5: Natural Filling (no-action alternative).** Continuing with the currently employed passive remediation. Ditch profiles indicate that the ditches are slowly shrinking in length as the distal ends fill.

All alternatives may require monitoring to evaluate success and impacts of the action. It should be noted that the affected ditches are not easily accessible to humans and are flooded twice daily by tidal action. Evaluation of remedial options must address access difficulties and reduced working periods due to tidal flooding. In addition, the adjacent marsh surface has high ecological value, and remedial actions must be designed to minimize damage to the wetland. The supplemental feasibility study will include an evaluation of habitat value of ditches and adjacent wetland that could be impacted by any action. Short-term and longer-term impacts of alternative actions on habitat value and special status species at the site should also be considered.

Altering or removing the ditches will affect marsh hydrology. Short-term and longer-term hydrologic impacts on contaminant transfer, erosion, and the wetland ecology should be considered in the supplemental feasibility study.

10.3.2.2 Supplemental Feasibility Study of Unit 11 Slough (RASS 1)

Another component of the supplemental feasibility study for the Litigation Area will focus on the east-west trending arm of Lost Slough known as Unit 11. Previous characterization has shown that sediment in Lost Slough (Unit 11) is contaminated with metals at concentrations that pose ecological risk. Vertical profiles of metals indicated that some portions of the slough bottom have been scoured, raising the possibility that contaminants may be mobilized in this side arm of Lost Slough.

The overall remedial goals for Unit 11 are to reduce ecological risk and reduce or eliminate mobilization of contaminated sediments from the Unit 11 portion of Lost Slough. Specific remedial action objectives

will be developed during the supplemental feasibility stage. At a minimum, the following remedial alternatives should be evaluated in the supplemental feasibility study:

- **Alternative 1: Active Removal of Contaminated Sediment**. Physical removal of contaminated sediments would eliminate concerns about mobilization and ecological risk.
    - **Alternative 1a**: Removal of all contaminated sediments in the Unit 11 slough
    - **Alternative 1b**: Removal of hotspots or isolated areas of highest contamination in the Unit 11 slough
- **Alternative 2: Install a Physical Barrier**. A physical barrier such as a layer of clean fill or gravel or a geomembrane at the bottom of the slough would prevent mobilization of contaminants and reduce exposure of organisms to bottom sediments.
    - **Alternative 2a**: Installing barrier along entire length of slough
    - **Alternative 2b**: Installing barrier in only part of the slough, where highest contaminant concentrations are present
- **Alternative 3: Combination of Alternatives**. Some combination of removal and physical barriers along all or part of the length of the slough.
- **Alternative 4: Passive Remediation (no-action alternative).** Continuing with the currently employed passive remediation.

It should be noted that Lost Slough is not easily accessible by humans and the nearby marsh surface is flooded twice daily. Remedial options must address access difficulties and reduced working periods due to tidal flooding. Lost Slough experiences higher flow velocities than the ditch system, and remedial options should consider ways to accommodate these flow velocities.

The supplemental feasibility study will consider and evaluate the ecological value of the tidal slough and adjacent wetland. Any remedial alternatives should be designed to minimize damage to the wetland and the tidal sloughs. The supplemental feasibility study will evaluate short-term and longer-term impacts of remedial alternatives on habitat value and special status species at the site.

Since Lost Slough acts as a sink for contaminants migrating down Nichols Creek, upgradient sources should be addressed before any additional action is implemented in Unit 11 to prevent recontamination of slough bottom sediments.

10.3.2.3 Supplemental Feasibility Study of Erosional Areas in RASS 3

The third component of the supplemental feasibility study for the Litigation Area will evaluate alternatives to reduce erosion along the length of Nichols Creek in RASS 3 (from the CPC northern boundary to the RASS 3 pond). Nichols Creek is an ephemeral stream that borders the CPC facility,

crosses through RASS 3, and empties into a small wetland in RASS 3, where it finally discharges into the slough in RASS 1. Contamination in the Nichols Creek area was remediated; however, this action did not establish a new bed for Nichols Creek. As a result, the creek has created its own course. The Navy and the regulatory agencies have observed and documented erosion of the creek bank (Appendix B). Erosion occurs in areas where nearby soils are contaminated, potentially mobilizing contaminants downstream toward the RASS 3 pond and into Lost Slough.

The goal of additional actions to be evaluated in this supplemental feasibility study would be to create a stable creek bed to prevent or decrease erosion of the creek bed and banks. Different sets of alternatives may be evaluated for erosional and depositional segments of the creek. At a minimum, the following remedial alternatives should be evaluated in the supplemental feasibility study:

- **Alternative 1: Restore Riparian Vegetation.** Vegetate unstable slopes to increase stability and decrease erosion of creek banks along all or part of the creek.
- **Alternative 2: Recontour Creek Bed**. Recontour all or part of the creek area to direct surface water flow to the desired flow pathway.
- **Alternative 3: Stabilize Creek Bed**. Line all or part of the creek bed with gravel, cobbles, or riprap to create a stable creek bed.
- **Alternative 4: Channelize Creek.** Channelize all or part of Nichols Creek by creating a concrete-lined creek bed.
- **Alternative 5: Engineered Sediment Trap**. Employ sediment trap, baffles, or other engineering solution to trap eroding sediment.
- **Alternative 6: Combination of Alternatives**. Some combination of alternatives along part or entire length of creek, with different actions in depositional and erosional segments.
- **Alternative 7: No-action Alternative**. Continuing with the currently employed passive approach.

It should be noted that the largest areas of active erosion occur on ATSF and Sacramento Northern railroad property easements near culverts that run beneath the railroad; the concentrations of metals in this area are unknown. The Navy would have to work with neighboring property owners to implement any actions along the entire creek length because it crosses the railroad easements.

Upgradient sources at CPC should be addressed before the Navy takes action to reduce erosion along Nichols Creek on Navy property, thereby preventing recontamination of the creek bottom. The supplemental feasibility study should evaluate various ways to minimize runoff to the pond in RASS 3 and the wetlands in RASS 1 during and following any actions.

11.0 NEXT REVIEW

This site requires ongoing five-year statutory reviews. The next review should be conducted within 5 years of the completion of the draft final five-year review report.

12.0 OTHER COMMENTS

The Navy will consult with the regulatory agencies about ongoing concerns regarding migration of contaminants from neighboring facilities onto Navy property and will consider whatever enforcement options are available and necessary.

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TABLES

TABLE 1

SITE CHRONOLOGY FOR THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Event	Date
Initial discovery of contamination; Department of Health Services notified Navy of the release from neighboring properties	August 1980
Navy began investigation of the release	1981
Initial site assessment completed	June 1983
Remedial investigation (RI) conducted (RI report completed)	June 1984 to September 1988 (January 1986)
Feasibility study completed Volume I: Remedial Action Alternatives Volume II: Biological Assessment	July 1988 September 1988
Record of decision/remedial action plan finalized	April 6, 1989
Monitoring plan for contamination remediation completed	April 1989
Preremediation monitoring (baseline conditions report completed)	1991 – monitoring conducted (1994 – report completed)
Remedial action subsites (RASS) 1 and 2 remedial actions (start to finish)	June 1993 – June 1996
RASS 3 remedial action (start to finish)	May 1993 – July 1994
RASS 4 remedial action (start to finish)	January 1993 – June 1994
Explanation of significant difference regarding addition of dewatering unit during remediation	August 1994
National Priorities List status	December 1994
RASSs 1 to 4 final revegetation monitoring plan completed	April 1995
After remediation (Year 1), remedial action monitoring report completed	May 1996
After remediation (Year 2), remedial action monitoring report completed	July 1997
Qualitative ecological assessment report finalized	September 1997
After remediation (Year 3), remedial action monitoring report completed	February 1998
After remediation (Year 4), remedial action monitoring report completed	January 1999
Initiation of 5-year review process	November 1999
After remediation (Year 5), remedial action monitoring completed	January 2000

TABLE 2

REMEDIAL ACTION SUBSITE 1 ACTIVE AREA
PREREMEDIATION REMEDIAL INVESTIGATION/FEASIBILITY STUDY SURFACE SOIL RESULTS
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location[1,2]	Sample ID	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Sample Date
16X6	AASCW16X6R1	3,486.20	0.16	563.61	200.80	---	373.90	1,288.30	0.06	208.27	74.20	---	138.20	6/86 WES sample[1,3]
	AASCW16X6R2	437.46	0.30	566.63	147.10	---	337.30	161.65	0.11	209.39	54.30	---	124.60	
	AASCW16X6R3	429.96	0.25	628.01	206.20	---	423.70	158.88	0.09	232.07	76.20	---	156.60	
16X5	AASCW16X5	165.37	0.92	123.21	32.40	---	71.70	60.52	0.34	45.09	11.80	---	26.20	6/86 WES sample[1,3]
16W1	AASCW16W1	1,955.30	5.82	355.11	123.50	---	1,550.50	742.42	2.21	134.83	46.90	---	588.70	6/86 WES resample[1,3]
16V1	AASCW16V1	844.89	7.51	361.71	76.60	---	742.94	330.97	2.94	141.70	30.00	---	291.00	6/86 WES resample[1,3]
16V2	AASCW16V2	845.98	1.16	576.95	192.40	---	528.70	318.96	0.44	217.53	72.50	---	199.30	6/86 WES resample[1,3]
16U5	AASCW16U5	1,029.70	3.90	858.50	25.90	---	878.00	281.20	1.10	234.40	7.10	---	240.00	12/86 WES sample[1,3]
16U6	AASCW16U6	234.70	2.90	208.00	11.90	---	357.00	83.50	1.00	74.00	4.20	---	127.00	12/86 WES sample[1,3]
16U7	AASCW16U7	1,999.70	17.20	803.50	35.60	---	2,238.00	644.20	5.60	258.80	11.60	---	721.00	12/86 WES sample[1,3]
16U1	AASCW16U1	28.25	0.74	229.30	17.40	---	245.59	9.38	0.24	76.15	5.80	---	81.60	6/86 WES resample[1,3]
16U8	AASCW16U8	1,329.70	0.00	681.00	69.90	---	280.00	543.30	0.00	278.30	28.60	---	115.00	12/86 WES sample[1,3]
15S3	ABSCW15S3	184.70	3.60	395.50	19.90	---	1,533.00	79.00	1.60	169.20	8.50	---	656.00	12/86 WES sample[1,3]
16U2	AASCW16U2	324.32	12.09	605.11	99.80	---	1,513.50	149.57	5.58	279.06	46.00	---	698.00	6/86 WES resample[1,3]
15S1	ABSCW15S1	364.53	10.96	626.44	112.30	---	1,205.10	168.25	5.06	289.13	51.80	---	556.20	6/86 WES resample[1,3]
15S2	ABSCW15S2	189.70	5.30	523.50	8.90	---	848.00	76.40	2.20	210.90	3.60	---	342.00	12/86 WES sample[1,3]
15R1	ABSCW15R1	61.15	0.83	444.15	29.00	---	370.67	37.30	0.51	270.91	17.70	---	226.10	6/86 WES resample[1,3]
15R2	ABSCW15R2	324.70	0.40	558.50	54.90	---	97.00	137.50	0.20	236.40	23.30	---	41.00	12/86 WES sample[1,3]
15Q2	ABSCW15Q2	214.70	4.60	476.00	24.90	---	433.00	137.40	2.90	304.60	16.00	---	277.00	12/86 WES sample[1,3]
15Q1	ABSCW15Q1	28.17	3.50	10,517.20	808.80	---	2,087.80	26.37	3.28	9,846.95	757.30	---	1,954.70	6/86 WES resample[1,3]
	Average	**723.96**	**4.11**	**1,005.10**	**114.91**	**NA**	**805.77**	**271.75**	**1.77**	**685.88**	**67.37**	**NA**	**378.01**	
	Standard Deviation	**878.84**	**4.68**	**2,246.78**	**176.00**	**NA**	**658.53**	**316.16**	**1.89**	**2,157.60**	**164.24**	**NA**	**434.12**	

Notes:

---	No data were available
ID	Identification
mg/kg	Milligram per kilogram
NA	Not applicable
WES	U.S. Army Corps of Engineers, Waterways Experiment Station

References:

1 Cullinane, M.J., Lee, C.R., and O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at Naval Weapons Staion Concord, California, Volume III: Figures." Miscellaneous Paper EL-86-3. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

2 Lee, C.R., and others. 1986. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

3 Lee, C.R., and others. 1988. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California, Subtitle Appendix 2.5 - 1986 to 1987 Data." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

TABLE 3

REMEDIAL ACTION SUBSITE 1 ACTIVE AREA
SURFACE SOIL SAMPLING RESULTS IMMEDIATELY AFTER REMEDIATION
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT

Location	Analyte Concentration[1] (mg/kg dry weight)					
	Arsenic	Cadmium[2]	Copper	Lead	Selenium[2]	Zinc
R01SS047	1,990.00	0.13	450.00	130.00	3.00	413.00
R01SS053	17.30	0.05	72.10	36.40	1.10	165.00
R01SS054	15.50	0.05	70.50	34.40	0.93	166.00
R01SS063	17.80	0.06	74.90	49.10	1.30	173.00
R01SS064	16.80	0.05	74.90	41.50	0.83	172.00
R01SS068	23.00	0.05	63.60	39.30	0.93	148.00
R01SS069	15.10	0.05	69.70	41.40	0.88	175.00
R01SS070	13.10	0.05	65.70	33.90	0.82	145.00
R01SS079	17.60	0.06	75.90	39.70	1.10	168.00
R01SS080	13.50	0.06	64.10	31.60	0.96	146.00
R01SS085	15.20	0.05	70.90	40.20	0.93	158.00
R01SS093	21.90	0.06	86.00	44.90	1.10	203.00
R01SS094	16.10	0.05	76.60	42.60	0.83	172.00
R01SS101	12.90	0.05	79.30	39.00	1.10	175.00
R01SS109	20.10	0.06	78.90	42.50	0.99	173.00
R01SS110	20.20	0.06	82.70	43.60	0.95	186.00
R01SS114	12.70	0.06	75.50	35.50	0.95	172.00
R01SS115	11.80	0.06	70.80	31.50	0.95	153.00
R01SS116	15.70	0.07	82.40	39.90	1.10	181.00
R01SS122	18.00	0.06	72.50	40.10	0.94	167.00
R01SS123	16.60	0.07	70.30	39.40	1.20	169.00
R01SS126	16.30	0.06	74.10	42.20	0.96	179.00
R01SS127	16.60	0.06	83.20	38.00	2.00	182.00
R01SS128	13.10	0.05	70.40	32.60	0.85	156.00
R01SS129	19.30	0.06	86.40	50.30	2.20	194.00
Mean	**95.45**	**0.06**	**89.66**	**43.18**	**1.16**	**179.64**
Standard Deviation	**394.71**	**0.02**	**75.33**	**18.71**	**0.51**	**50.60**
WCC[3] (mg/kg dry weight)	**< 33**	**< 5**	**< 90**	**< 50**	**< 0.7**	**< 160**
TTLC[4] (mg/kg wet weight)	**500.00**	**100.00**	**2,500.00**	**1,000.00**	**100.00**	**5,000.00**

Notes:

1 PRC Environmental Management, Inc. 1996. "After Remediation (Year 1) Remedial Action Monitoring Report, Naval Weapons Station Concord, Litigation Area." May.

2 All cadmium and selenium analysis results were below detection limits; detection limits are shown in the table.

3 California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Region. 1992. "Interim Final Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse." Prepared by Wolfenden, J.D., and M.P. Carlin. December.

4 *California Code of Regulations.* Title 22, Social Security. Division 4.5, Environmental Health Standards for the Management of Hazardous Waste. Chapter 11, Identification and Listing of Hazardous Waste. Article 3, Characteristics of Hazardous Waste. Section 66261.24, Characteristic of Toxicity.

< Less than
bgs Below ground surface
mg/kg Milligram per kilogram
TTLC Total threshold limit concentration
WWC Wetland creation cover

TABLE 4

REMEDIAL ACTION SUBSITE 2 ACTIVE AREA, PREREMEDIATION CHARACTERIZATION STUDY SOIL SAMPLING RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

			Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	Sample ID	Sample Depth (feet bgs)	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Sample Date
8R3	KSSCW8R3D1	0.0 - 0.5	18.70	22.60	81.00	71.90	---	6,198.00	11.20	13.50	48.50	43.10	---	3,710.00	12/86 WES sample[1,3]
	KSSCW8R3D2	0.5 - 1.0	8.50	9.70	38.00	13.30	---	3,823.00	4.60	5.30	20.70	7.20	---	2,079.00	
	KSSCW8R3D3	1.0 - 2.0	15.70	18.10	42.70	31.00	---	2,228.00	8.60	9.80	23.20	16.90	---	1,210.00	
	KSSCW8R3D4	2.0 - 3.0	4.40	15.20	34.10	1.30	---	2,648.00	2.20	7.70	17.20	0.70	---	1,339.00	
10R1	KSSCW10R1	0.0 - 0.5	71.60	28.11	163.89	58.20	---	4,439.10	40.25	15.80	92.13	32.70	---	2,495.40	6/86 WES resample[1,3]
10R7	KSSCW10R7D1	0.0 - 0.5	53.50	12.20	415.70	749.90	---	3,528.00	26.50	6.00	206.10	371.80	---	1,749.00	12/86 WES sample[1,3]
	KSSCW10R7D2	0.5 - 1.0	21.90	13.60	46.30	57.90	---	2,533.00	15.20	9.50	32.20	40.20	---	1,758.00	
	KSSCW10R7D3	1.0 - 2.0	15.30	3.30	27.10	4.70	---	2,118.00	9.70	2.10	17.10	3.00	---	1,338.00	
	KSSCW10R7D4	2.0 - 3.0	33.00	7.30	58.50	17.80	---	2,163.00	17.20	3.80	30.40	9.30	---	1,125.00	
11R6	KSSCW11R6D1	0.0 - 0.5	18.70	26.20	406.50	43.50	---	1,743.00	13.10	18.40	284.60	30.40	---	1,220.00	12/86 WES sample[1,3]
	KSSCW11R6D2	0.5 - 1.0	9.20	39.20	110.00	6.20	---	1,508.00	6.50	27.80	78.00	4.40	---	1,070.00	
	KSSCW11R6D3	1.0 - 2.0	14.70	37.10	33.70	4.50	---	3,648.00	9.90	25.00	22.70	3.00	---	2,460.00	
	KSSCW11R6D4	2.0 - 3.0	6.10	16.30	19.10	1.90	---	1,473.00	4.30	11.40	13.30	1.30	---	1,027.00	
10R3	KSSCW10R3	0.0 - 0.5	8.94	1.78	108.02	441.70	---	589.70	7.98	1.59	96.42	394.30	---	526.40	6/86 WES sample[1,3]
10R4	KSSCW10R4	0.0 - 0.5	18.05	6.41	165.60	296.20	---	888.40	17.12	6.08	157.08	281.00	---	842.70	6/86 WES sample[1,3]
11R4	KSSCW11R4D1	0.0 - 0.5	195.70	2.30	264.00	13.00	---	361.00	165.90	2.00	223.70	11.00	---	306.00	12/86 WES sample[1,3]
	KSSCW11R4D2	0.5 - 1.0	27.00	9.20	199.00	4.40	---	1,893.00	21.50	7.30	158.40	3.50	---	1,506.00	
	KSSCW11R4D3	1.0 - 2.0	26.90	17.20	307.50	0.00	---	4,958.00	21.80	14.00	248.90	0.00	---	4,014.00	
	KSSCW11R4D4	2.0 - 3.0	4.70	6.30	19.90	4.30	---	1,678.00	3.70	5.00	15.60	3.40	---	1,312.00	
11R8	KSSCW11R8D1	0.0 - 0.5	26.90	2.30	163.50	6.20	---	127.00	24.60	2.10	149.40	5.70	---	116.00	12/86 WES sample[1,3]
	KSSCW11R8D2	0.5 - 1.0	22.70	1.20	351.00	6.40	---	250.00	19.40	1.00	299.50	5.40	---	213.00	
	KSSCW11R8D3	1.0 - 2.0	7.50	0.30	52.00	3.00	---	179.00	6.90	0.30	47.30	2.70	---	163.00	
	KSSCW11R8D4	2.0 - 3.0	4.10	0.70	35.80	3.40	---	65.00	3.70	0.70	31.90	3.10	---	58.00	
11R9	KSSCW11R9D1	0.0 - 0.5	569.70	0.20	282.50	19.00	---	241.00	493.90	0.20	244.90	16.50	---	209.00	12/86 WES sample[1,3]
	KSSCW11R9D2R1	0.5 - 1.0	82.20	4.30	523.50	22.90	---	477.00	66.20	3.50	421.50	18.50	---	384.00	
	KSSCW11R9D2R2	0.5 - 1.0	143.70	3.50	383.00	39.90	---	480.00	115.70	2.90	308.30	32.10	---	386.00	
	KSSCW11R9D2R3	0.5 - 1.0	108.70	6.20	446.50	34.90	---	533.00	87.50	5.00	359.50	28.10	---	429.00	
	KSSCW11R9D3R1	1.0 - 2.0	57.70	5.20	461.50	19.90	---	573.00	46.30	4.20	370.10	16.00	---	460.00	
	KSSCW11R9D3R2	1.0 - 2.0	40.70	5.60	453.00	15.90	---	568.00	32.70	4.50	363.30	12.80	---	456.00	
	KSSCW11R9D3R3	1.0 - 2.0	50.70	4.80	471.50	17.20	---	583.00	40.70	3.90	378.10	13.80	---	468.00	
	KSSCW11R9D4	2.0 - 3.0	149.70	5.80	402.00	9.80	---	515.00	117.50	4.60	315.40	7.70	---	404.00	
12R4	KSSCW12R4D1	0.0 - 0.5	5.30	0.00	15.50	6.10	---	46.00	4.90	0.00	14.20	5.50	---	42.00	12/86 WES sample[1,3]
	KSSCW12R4D2R1	0.5 - 1.0	2.50	0.00	14.50	1.80	---	36.00	2.20	0.00	12.70	1.60	---	31.00	
	KSSCW12R4D2R2	0.5 - 1.0	2.30	0.00	14.10	1.80	---	32.00	2.10	0.00	12.40	1.60	---	28.00	
	KSSCW12R4D2R3	0.5 - 1.0	3.40	0.00	13.40	1.30	---	31.00	3.00	0.00	11.80	1.20	---	27.00	
	KSSCW12R4D3	1.0 - 2.0	3.30	0.30	17.20	5.30	---	54.00	2.90	0.30	14.80	4.60	---	47.00	
	KSSCW12R4D4	2.0 - 3.0	3.10	0.90	17.30	5.80	---	45.00	2.70	0.80	15.10	5.00	---	39.00	
10P1	KSSCW10P1	0.0 - 0.5	27.64	88.51	1,498.48	4,675.21	0.05	50,276.90	---	---	---	---	---	---	1984 WES sample[1,2]
9Q3	KSSCW9Q3D1	0.0 - 0.5	9.90	28.10	262.50	1,059.90	---	11,998.00	9.00	25.30	236.70	955.80	---	10,820.00	12/86 WES sample[1,3]
	KSSCW9Q3D2	0.5 - 1.0	6.10	13.60	74.00	125.90	---	6,798.00	5.60	12.50	68.00	115.80	---	6,250.00	
	KSSCW9Q3D3	1.0 - 2.0	6.90	14.00	80.00	97.90	---	11,748.00	6.20	12.40	71.10	87.00	---	10,435.00	
	KSSCW9Q3D4	2.0 - 3.0	6.90	14.80	112.70	429.90	---	12,773.00	6.20	13.20	100.40	383.00	---	11,378.00	
9Q1	KSSCW9Q1	0.0 - 0.5	7.06	28.74	69.46	74.30	---	7,429.50	4.80	19.55	47.24	50.50	---	5,053.50	6/86 WES resample[1,3]
9Q2	KSSCW9Q2D1	0.0 - 0.5	10.20	26.50	89.50	689.90	---	8,698.00	7.80	20.10	67.90	523.40	---	6,599.00	12/86 WES sample[1,3]
	KSSCW9Q2D2	0.5 - 1.0	5.80	4.00	18.60	179.90	---	1,278.00	4.40	3.10	14.00	135.70	---	964.00	
	KSSCW9Q2D3	1.0 - 2.0	4.20	8.00	27.90	43.40	---	1,378.00	3.00	5.70	19.90	31.00	---	985.00	
	KSSCW9Q2D4R1	2.0 - 3.0	5.60	5.20	28.50	142.90	---	2,450.00	3.90	3.60	19.90	99.60	---	1,708.00	
	KSSCW9Q2D4R2	2.0 - 3.0	7.70	5.80	43.20	539.90	---	3,098.00	5.40	4.00	30.10	376.30	---	2,159.00	
	KSSCW9Q2D4R3	2.0 - 3.0	10.70	9.60	40.20	609.90	---	3,643.00	7.50	6.70	28.00	425.00	---	2,539.00	

TABLE 4 (Continued)

REMEDIAL ACTION SUBSITE 2 ACTIVE AREA, PREREMEDIATION CHARACTERIZATION STUDY SOIL SAMPLING RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

			Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	Sample ID	Sample Depth (feet bgs)	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Sample Date
10R5	KSSCW10R5D1	0.0 - 0.5	34.20	50.10	361.50	809.90	---	15,998.00	26.40	38.70	278.90	624.90	---	12,344.00	12/86 WES sample[1,3]
	KSSCW10R5D2	0.5 - 1.0	24.90	32.40	177.00	35.20	---	9,098.00	20.00	26.00	142.10	28.20	---	7,302.00	
	KSSCW10R5D3R1	1.0 - 2.0	11.90	34.00	148.00	1,864.90	---	13,698.00	8.70	24.70	107.50	1,354.40	---	9,948.00	
	KSSCW10R5D3R2	1.0 - 2.0	13.50	17.40	32.50	199.90	---	7,348.00	9.80	12.70	23.60	145.20	---	5,336.00	
	KSSCW10R5D3R3	1.0 - 2.0	9.60	13.50	40.50	262.90	---	5,898.00	7.00	9.80	29.40	190.90	---	4,283.00	
	KSSCW10R5D4	2.0 - 3.0	9.10	19.00	95.00	1,159.90	---	10,448.00	5.80	12.00	59.90	731.00	---	6,584.00	
10Q2	KSSCW10Q2D1R1	0.0 - 0.5	23.50	33.80	313.50	1,789.90	---	13,623.00	20.40	29.30	271.70	1,551.30	---	11,807.00	12/86 WES sample[1,3]
	KSSCW10Q2D1R2	0.0 - 0.5	27.70	39.70	382.00	2,509.90	---	11,198.00	24.00	34.40	331.10	2,175.30	---	9,705.00	
	KSSCW10Q2D1R3	0.0 - 0.5	22.70	34.90	335.50	2,119.90	---	10,748.00	19.70	30.20	290.80	1,837.30	---	9,315.00	
	KSSCW10Q2D2R1	0.5 - 1.0	14.20	23.00	113.50	1,354.90	---	9,698.00	12.90	20.80	102.40	1,222.90	---	8,753.00	
	KSSCW10Q2D2R2	0.5 - 1.0	13.50	19.00	155.00	1,209.90	---	8,298.00	12.20	17.20	139.90	1,092.00	---	7,489.00	
	KSSCW10Q2D2R3	0.5 - 1.0	12.90	19.30	162.00	1,189.90	---	7,998.00	11.70	17.40	146.20	1,074.00	---	7,219.00	
	KSSCW10Q2D3	1.0 - 2.0	12.90	16.80	141.00	1,209.90	---	7,198.00	11.30	14.70	122.60	1,052.50	---	6,261.00	
	KSSCW10Q2D4	2.0 - 3.0	9.60	10.10	94.00	759.90	---	4,943.00	8.30	8.70	80.70	652.60	---	4,245.00	
10Q1	KSSCW10Q1D1	0.0 - 0.5	22.90	17.70	788.50	1,009.90	---	1,258.00	18.80	14.50	644.60	825.60	---	1,028.00	12/86 WES sample[1,3]
	KSSCW10Q1D2R1	0.5 - 1.0	18.70	26.50	231.70	429.90	---	7,773.00	15.20	21.50	187.50	347.80	---	6,288.00	
	KSSCW10Q1D2R2	0.5 - 1.0	20.70	23.10	185.50	379.90	---	5,298.00	16.80	18.70	150.00	307.30	---	4,286.00	
	KSSCW10Q1D2R3	0.5 - 1.0	20.20	24.90	224.50	479.90	---	8,198.00	16.40	20.10	181.60	388.20	---	6,631.00	
	KSSCW10Q1D3	1.0 - 2.0	15.30	22.20	146.00	459.90	---	5,298.00	12.40	18.00	118.00	371.90	---	4,284.00	
	KSSCW10Q1D4	2.0 - 3.0	9.70	11.00	65.50	366.90	---	3,388.00	7.80	8.80	52.10	292.00	---	2,696.00	
10R6	KSSCW10R6D1	0.0 - 0.5	14.80	31.70	81.50	64.40	---	5,298.00	11.40	24.50	63.00	49.80	---	4,098.00	12/86 WES sample[1,3]
	KSSCW10R6D2	0.5 - 1.0	12.90	29.90	21.40	5.60	---	3,943.00	9.10	21.20	15.20	4.00	---	2,797.00	
	KSSCW10R6D3	1.0 - 2.0	6.40	41.70	27.50	2.90	---	5,448.00	4.40	28.60	18.90	2.00	---	3,738.00	
	KSSCW10R6D4R1	2.0 - 3.0	5.70	16.70	33.10	31.90	---	3,608.00	3.70	10.90	21.60	20.80	---	2,355.00	
	KSSCW10R6D4R2	2.0 - 3.0	5.70	13.30	27.40	11.90	---	3,013.00	3.70	8.70	17.90	7.80	---	1,967.00	
	KSSCW10R6D4R3	2.0 - 3.0	6.20	15.10	27.60	1.80	---	3,368.00	4.10	9.90	18.00	1.20	---	2,198.00	
10Q3	KSSCW10Q3D1	0.0 - 0.5	113.70	2.10	212.00	264.90	---	683.00	96.40	1.80	179.70	224.60	---	579.00	12/86 WES sample[1,3]
	KSSCW10Q3D2	0.5 - 1.0	489.70	5.20	274.50	779.90	---	903.00	410.30	4.40	230.00	653.40	---	757.00	
	KSSCW10Q3D3	1.0 - 2.0	53.70	8.60	57.00	33.40	---	1,698.00	43.90	7.00	46.60	27.30	---	1,387.00	
	KSSCW10Q3D4	2.0 - 3.0	8.10	1.30	26.70	20.90	---	313.00	6.40	1.00	21.20	16.60	---	248.00	
11Q9	KSSCW11Q9D1S1	0.0 - 1.0	784.52	3.61	258.06	516.13	0.95	258.06	608.00	2.80	200.00	400.00	0.74	200.00	3/87 WES sample[1,3]
	KSSCW11Q9D2S1	1.0 - 2.0	370.66	6.95	656.37	56.63	1.80	669.24	288.00	5.40	510.00	44.00	1.40	520.00	
	KSSCW11Q9D3S1	2.0 - 3.0	47.18	11.66	301.44	22.28	1.44	1,310.62	36.00	8.90	230.00	17.00	1.10	1,000.00	
	KSSCW11Q9D4S1	3.0 - 4.0	29.38	1.47	45.29	17.14	1.71	75.89	24.00	1.20	37.00	14.00	1.40	62.00	
	KSSCW11Q9D5S1	4.0 - 5.0	32.10	1.12	16.05	13.58	0.62	38.27	26.00	0.91	13.00	11.00	0.50	31.00	
	KSSCW11Q9D6S1	5.0 - 6.0	10.00	1.52	22.78	21.52	0.63	58.23	7.90	1.20	18.00	17.00	0.50	46.00	
11Q3	KSSCW11Q3D1R1	0.0 - 0.5	219.70	0.00	268.00	184.40	---	212.00	190.90	0.00	232.80	160.20	---	184.00	12/86 WES sample[1,3]
	KSSCW11Q3D1R2	0.0 - 0.5	229.70	1.30	270.50	139.90	---	187.00	199.60	1.10	235.00	121.60	---	163.00	
	KSSCW11Q3D1R3	0.0 - 0.5	244.70	1.40	268.00	236.90	---	193.00	212.60	1.20	232.80	205.80	---	168.00	
	KSSCW11Q3D2	0.5 - 1.0	154.70	2.40	299.50	207.90	---	263.00	131.40	2.10	254.30	176.60	---	224.00	
	KSSCW11Q3D3	1.0 - 2.0	93.70	0.00	258.00	86.90	---	346.00	77.20	0.00	212.40	71.60	---	285.00	
	KSSCW11Q3D4	2.0 - 3.0	237.70	2.20	253.00	162.90	---	323.00	194.50	1.80	207.00	133.30	---	264.00	
11Q4	KSSCW11Q4D1S1	0.0 - 1.0	471.09	3.81	356.70	41.82	1.48	307.50	383.00	3.10	290.00	34.00	1.20	250.00	3/87 WES sample[1,3]
	KSSCW11Q4D2S1	1.0 - 2.0	43.91	5.27	501.88	26.35	1.19	464.24	35.00	4.20	400.00	21.00	0.95	370.00	
	KSSCW11Q4D3S1	2.0 - 3.0	41.83	6.46	240.81	24.08	2.03	481.62	33.00	5.10	190.00	19.00	1.60	380.00	
	KSSCW11Q4D4S1	3.0 - 4.0	26.57	2.54	43.48	24.15	1.03	132.85	22.00	2.10	36.00	20.00	0.85	110.00	
	KSSCW11Q4D5S1	4.0 - 5.0	54.48	1.94	18.16	21.79	2.18	46.00	45.00	1.60	15.00	18.00	1.80	38.00	
	KSSCW11Q4D6S1	5.0 - 6.0	60.39	2.05	25.36	25.36	0.71	91.79	50.00	1.70	21.00	21.00	0.59	76.00	

TABLE 4 (Continued)

REMEDIAL ACTION SUBSITE 2 ACTIVE AREA, PREREMEDIATION CHARACTERIZATION STUDY SOIL SAMPLING RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

			Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	Sample ID	Sample Depth (feet bgs)	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Sample Date
11Q5	KSSCW11Q5D1S1	0.0 - 1.0	317.79	3.80	380.37	82.21	1.21	282.21	259.00	3.10	310.00	67.00	0.99	230.00	3/87 WES sample[1,3]
	KSSCW11Q5D2S1	1.0 - 2.0	62.02	4.91	658.91	36.18	1.01	478.04	48.00	3.80	510.00	28.00	0.78	370.00	
	KSSCW11Q5D3S1	2.0 - 3.0	46.33	11.45	501.93	29.60	2.32	1,055.34	36.00	8.90	390.00	23.00	1.80	820.00	
	KSSCW11Q5D4S1	3.0 - 4.0	76.05	8.24	633.71	22.81	1.08	988.59	60.00	6.50	500.00	18.00	0.85	780.00	
	KSSCW11Q5D5S1	4.0 - 5.0	24.21	4.84	38.74	20.58	1.11	593.22	20.00	4.00	32.00	17.00	0.92	490.00	
	KSSCW11Q5D6S1	5.0 - 6.0	29.74	2.35	26.02	24.78	1.86	235.44	24.00	1.90	21.00	20.00	1.50	190.00	
11Q2	KSSCW11Q2D1	0.0 - 0.5	819.70	4.50	294.00	56.90	---	308.00	680.10	3.70	243.90	47.20	---	256.00	12/86 WES sample[1,3]
	KSSCW11Q2D2	0.5 - 1.0	589.70	6.70	593.50	155.90	---	678.00	446.80	5.10	449.60	118.10	---	514.00	
	KSSCW11Q2D3	1.0 - 2.0	109.70	11.20	793.50	22.90	---	1,188.00	88.30	8.50	602.30	17.40	---	902.00	
	KSSCW11Q2D4	2.0 - 3.0	17.70	14.40	430.00	2.20	---	1,238.00	13.40	10.80	323.90	1.70	---	932.00	
11Q6	KSSCW11Q6D1S1	0.0 - 1.0	338.98	1.94	113.80	25.42	1.10	205.81	280.00	1.60	94.00	21.00	0.91	170.00	3/87 WES sample[1,3]
	KSSCW11Q6D2S1	1.0 - 2.0	300.76	3.05	139.59	5.84	1.15	266.50	237.00	2.40	110.00	4.60	0.91	210.00	
	KSSCW11Q6D3S1	2.0 - 3.0	71.34	4.28	7.13	7.00	1.43	440.99	55.00	3.30	5.50	5.40	1.10	340.00	
	KSSCW11Q6D4S1	3.0 - 4.0	82.56	1.16	2.00	9.59	1.60	17.31	62.00	0.87	1.50	7.20	1.20	13.00	
	KSSCW11Q6D5S1	4.0 - 5.0	80.90	0.73	1.99	6.50	1.72	13.26	61.00	0.55	1.50	4.90	1.30	10.00	
	KSSCW11Q6D6S1	5.0 - 6.0	30.22	0.75	4.73	8.15	0.68	34.17	23.00	0.57	3.60	6.20	0.52	26.00	
11Q1	KSSCW11Q1D1	0.0 - 0.5	444.70	3.90	290.00	103.90	---	312.00	371.40	3.30	242.20	86.80	---	261.00	12/86 WES sample[1,3]
	KSSCW11Q1D2	0.5 - 1.0	634.70	4.30	398.00	196.40	---	496.00	489.40	3.30	306.90	151.40	---	382.00	
	KSSCW11Q1D3	1.0 - 2.0	404.70	5.20	521.00	61.90	---	648.00	311.40	4.00	400.80	47.60	---	499.00	
	KSSCW11Q1D4	2.0 - 3.0	53.20	9.70	773.50	18.90	---	1,108.00	41.00	7.50	595.70	14.60	---	853.00	
11Q8	KSSCW11Q8D1S1	0.0 - 1.0	659.73	6.24	477.36	134.64	0.87	563.04	539.00	5.10	390.00	110.00	0.71	460.00	3/87 WES sample[1,3]
	KSSCW11Q8D2S1	1.0 - 2.0	133.85	9.01	553.41	25.74	1.29	862.29	104.00	7.00	430.00	20.00	1.00	670.00	
	KSSCW11Q8D3S1	2.0 - 3.0	44.10	9.99	28.53	19.46	1.27	881.97	34.00	7.70	22.00	15.00	0.98	680.00	
	KSSCW11Q8D4S1	3.0 - 4.0	49.14	1.84	20.88	17.20	1.12	76.17	40.00	1.50	17.00	14.00	0.91	62.00	
	KSSCW11Q8D5S1	4.0 - 5.0	58.23	2.28	16.46	24.05	0.99	78.48	46.00	1.80	13.00	19.00	0.78	62.00	
	KSSCW11Q8D6S1	5.0 - 6.0	28.75	1.63	18.75	18.75	0.63	51.25	23.00	1.30	15.00	15.00	0.50	41.00	
11Q7	KSSCW11Q7D1S1	0.0 - 1.0	688.86	3.84	243.28	345.71	0.64	294.49	538.00	3.00	190.00	270.00	0.50	230.00	3/87 WES sample[1,3]
	KSSCW11Q7D2S1	1.0 - 2.0	43.93	9.04	555.56	41.34	1.11	826.87	34.00	7.00	430.00	32.00	0.86	640.00	
	KSSCW11Q7D3S1	2.0 - 3.0	28.17	8.32	358.51	26.89	0.74	909.09	22.00	6.50	280.00	21.00	0.58	710.00	
	KSSCW11Q7D4S1	3.0 - 4.0	33.99	8.89	30.07	22.22	1.44	575.16	26.00	6.80	23.00	17.00	1.10	440.00	
	KSSCW11Q7D5S1	4.0 - 5.0	44.04	1.81	25.91	28.50	0.76	53.11	34.00	1.40	20.00	22.00	0.59	41.00	
	KSSCW11Q7D6S1	5.0 - 6.0	30.26	1.39	20.18	20.18	0.88	50.44	24.00	1.10	16.00	16.00	0.70	40.00	
11Q12	KSSCW11Q12D1S1	0.0 - 1.0	216.03	1.51	139.37	19.74	1.63	127.76	186.00	1.30	120.00	17.00	1.40	110.00	3/87 WES sample[1,3]
	KSSCW11Q12D2S1	1.0 - 2.0	93.17	2.73	360.25	21.12	1.22	223.60	75.00	2.20	290.00	17.00	0.98	180.00	
	KSSCW11Q12D3S1	2.0 - 3.0	68.42	7.76	81.58	9.21	1.32	723.68	52.00	5.90	62.00	7.00	1.00	550.00	
	KSSCW11Q12D4S1	3.0 - 4.0	77.92	5.06	422.08	14.29	1.56	428.57	60.00	3.90	325.00	11.00	1.20	330.00	
	KSSCW11Q12D5S1	4.0 - 5.0	53.32	1.30	20.81	9.23	1.11	62.42	41.00	1.00	16.00	7.10	0.85	48.00	
	KSSCW11Q12D6S1	5.0 - 6.0	52.03	0.75	7.99	5.33	1.15	31.73	41.00	0.59	6.30	4.20	0.91	25.00	
11Q10	KSSCW11Q10D1S1	0.0 - 1.0	266.27	2.05	168.67	49.40	0.60	204.82	221.00	1.70	140.00	41.00	0.50	170.00	3/87 WES sample[1,3]
	KSSCW11Q10D2S1	1.0 - 2.0	47.20	3.35	40.99	8.82	1.22	298.14	38.00	2.70	33.00	7.10	0.98	240.00	
	KSSCW11Q10D3S1	2.0 - 3.0	51.83	1.05	17.70	7.59	1.15	68.27	41.00	0.83	14.00	6.00	0.91	54.00	
	KSSCW11Q10D4S1	3.0 - 4.0	36.52	1.26	16.37	10.45	0.88	60.45	29.00	1.00	13.00	8.30	0.70	48.00	
	KSSCW11Q10D5S1	4.0 - 5.0	21.12	1.03	10.68	7.45	0.62	32.30	17.00	0.83	8.60	6.00	0.50	26.00	
	KSSCW11Q10D6S1	5.0 - 6.0	35.94	0.93	12.27	11.77	1.13	38.41	29.00	0.75	9.90	9.50	0.91	31.00	

TABLE 4 (Continued)

REMEDIAL ACTION SUBSITE 2 ACTIVE AREA, PREREMEDIATION CHARACTERIZATION STUDY SOIL SAMPLING RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

			Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	**Sample ID**	**Sample Depth (feet bgs)**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Sample Date**
11Q11	KSSCW11Q11D1S1	0.0 - 1.0	124.21	2.28	177.44	17.74	0.82	253.49	98.00	1.80	140.00	14.00	0.65	200.00	3/87 WES sample[1,3]
	KSSCW11Q11D2S1	1.0 - 2.0	48.28	1.05	16.52	12.07	1.40	45.74	38.00	0.83	13.00	9.50	1.10	36.00	
	KSSCW11Q11D3S1	2.0 - 3.0	27.27	1.30	24.68	18.18	1.01	55.84	21.00	1.00	19.00	14.00	0.78	43.00	
	KSSCW11Q11D4S1	3.0 - 4.0	50.96	0.85	10.32	10.57	1.27	28.03	40.00	0.67	8.10	8.30	1.00	22.00	
	KSSCW11Q11D5S1	4.0 - 5.0	52.70	1.23	18.38	19.61	0.86	40.44	43.00	1.00	15.00	16.00	0.70	33.00	
	KSSCW11Q11D6S1	5.0 - 6.0	46.13	0.97	7.73	8.23	1.06	41.15	37.00	0.78	6.20	6.60	0.85	33.00	

Notes:

--- No data were available
bgs Below ground surface
ID Identification
mg/kg Milligram per kilogram
NA Not applicable
WES U.S. Army Corps of Engineers, Waterways Experiment Station

References:

1 Cullinane, M.J., Lee, C.R., and O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at Naval Weapons Staion Concord, California, Volume III: Figures." Miscellaneous Paper EL-86-3. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

2 Lee, C.R., and others. 1986. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

3 Lee, C.R., and others. 1988. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California, Subtitle Appendix 2.5 - 1986 to 1987 Data." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

TABLE 5

REMEDIAL ACTION SUBSITE 2 ACTIVE AREA,
SURFACE SOIL SAMPLING RESULTS IMMEDIATELY AFTER REMEDIATION
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Analyte Concentration[1] (mg/kg dry weight)					
	Arsenic	Cadmium[2]	Copper	Lead	Selenium[3]	Zinc
R02SS136	13.80	*0.06*	73.50	36.90	1.00	174.00
R02SS137	10.80	1.20	42.70	24.20	2.30	295.00
R02SS139	18.10	*0.06*	76.10	45.70	0.94	176.00
R02SS140	17.30	*0.05*	84.50	38.20	0.90	180.00
R02SS141	16.10	*0.06*	89.00	40.40	1.00	206.00
R02SS144	7.90	16.10	25.80	8.20	1.40	1,700.00
R02SS145	17.40	*0.04*	71.20	41.20	2.30	316.00
R02SS146	5.80	*0.04*	19.80	10.60	0.74	58.50
R02SS148	27.40	14.00	130.00	190.00	0.72	4,140.00
R02SS149	5.00	3.80	18.80	6.80	1.00	673.00
R02SS150	212.00	15.60	355.00	140.00	1.60	3,880.00
Mean	**31.96**	**5.10**	**89.67**	**52.93**	**1.26**	**1,072.59**
Standard Deviation	**60.06**	**7.11**	**94.36**	**58.25**	**0.57**	**1,523.43**
TTLC[4] (mg/kg wet weight)	**500.00**	**100.00**	**2,500.00**	**1,000.00**	**100.00**	**5,000.00**

Notes:

1 PRC Environmental Management, Inc. 1996. "After Remediation (Year 1) Remedial Action Monitoring Report, Naval Weapons Station Concord, Litigation Area." May.

2 Cadmium analysis results in *italics* were below detection limits; the sample detection limit is shown in the table.

3 Selenium analysis results were below detection limits; detections limits are shown in the table.

4 *California Code of Regulations.* Title 22, Social Security. Division 4.5, Environmental Health Standards for the Management of Hazardous Waste. Chapter 11, Identification and Listing of Hazardous Waste. Article 3, Characteristics of Hazardous Waste. Section 66261.24, Characteristic of Toxicity.

bgs Below ground surface
mg/kg Milligram per kilogram
TTLC Total threshold limit concentration

TABLE 6

REMEDIAL ACTION SUBSITE 3 ACTIVE AREA,
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PREREMEDIATION SURFACE SOIL RESULTS
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	Sample ID	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Sample Date
3R1	K2SCW3R1	7.03	2.79	43.51	108.80	---	737.80	4.08	1.62	25.23	63.10	---	427.90	6/86 WES resample[1,3]
4R1	K2SCPCW4R1	4.46	1.76	46.50	251.21	0.00	230.40	---	---	---	---	---	---	1984 WES sample[1,2]
4Q1	K2SCW4Q1	10.34	27.60	168.89	157.40	---	2,791.00	4.80	12.80	78.35	73.00	---	1,294.70	6/86 WES resample[1,3]
5P2	K2SCW5P2	6.11	34.23	238.37	481.50	---	6,284.00	2.88	16.17	112.60	227.40	---	2,968.70	6/86 WES resample[1,3]
5P3	K2SCW5P3	2.97	52.81	118.16	25.00	---	5,319.30	1.70	30.28	67.75	14.30	---	3,050.10	6/86 WES sample[1,3]
5P1	K2SCW5P1	3.74	0.60	69.34	51.31	1.30	270.50	---	---	---	---	---	---	1984 contractor sample[1,2]
6P2	K2SCW6P2	11.51	44.82	920.04	2,021.20	---	17,467.50	5.98	23.31	478.50	1,051.20	---	9,084.60	6/86 WES resample[1,3]
6Q2	K2SCW6Q2	2.55	36.16	30.28	1.07	0.00	4,953.10	---	---	---	---	---	…	1984 contractor sample[1,2]
6Q2	K2SCW6Q2	4.81	8.16	103.71	151.20	---	4,986.20	4.20	7.12	90.48	131.90	---	4,350.00	6/86 WES resample[1,3]
6P1	K2SCW6P1	36.76	38.46	2,070.61	297.10	---	53,686.50	26.51	27.73	1,493.02	214.30	---	38,710.90	6/86 WES resample[1,3]
6Q1	K2SCW6Q1	5.07	16.60	108.19	292.80	---	5,010.50	4.19	13.70	89.26	241.60	---	4,133.70	6/86 WES resample[1,3]
8P1	K2SCPCW8P1	13.75	31.75	1,188.30	1,769.73	0.25	21,894.20	---	---	---	---	---	---	1984 WES sample[1,2]
8P2	K2SCPCW8P2	57.25	45.15	3,053.30	7,599.72	0.60	85,494.20	---	---	---	---	---	---	1984 WES sample[1,2]
8P3	K2SCPCW8P3R1	2.75	16.40	80.81	119.23	0.00	5,294.20	---	---	---	---	---	---	1984 WES sample[1,2]
	K2SCPCW8P3R2	1.75	19.25	87.31	130.72	0.00	5,244.20	---	---	---	---	---	---	
	K2SCPCW8P3R3	3.71	26.29	317.14	35.37	0.00	9,004.10	---	---	---	---	---	---	
10P2	K2SCW10P2	18.29	7.65	110.82	663.80	---	4,164.20	17.35	7.26	105.16	629.90	---	3,951.50	6/86 WES sample[1,3]
11O1	G1SCW1101-1	4.87	15.91	129.87	70.60	---	7,304.26	4.54	14.83	120.99	65.80	---	6,804.90	6/86 WES resample[1,3]
12O1	G1SCW1201-1	4.64	12.06	128.30	26.60	---	6,913.16	4.38	11.38	121.11	25.10	---	6,526.10	6/86 WES resample[1,3]
12N1	G1SCW12N1-1	12.67	40.18	492.90	4,027.50	---	30,210.90	11.36	36.01	441.84	3,610.30	---	27,081.40	6/86 WES resample[1,3]
12N2	G1SCW12N2A	3.34	11.12	44.69	182.20	---	3,711.70	1.93	6.42	25.79	105.10	---	2,142.10	6/86 WES resample[1,3]
	G1SCW12N2B	3.92	16.81	71.06	341.60	---	6,221.40	2.06	8.85	37.40	179.80	---	3,274.30	
13M1	G1SCW13M1-1	41.22	17.25	912.30	742.90	---	8,208.40	26.08	10.91	577.19	470.00	---	5,193.30	6/86 WES resample[1,3]
13L5	G1SCW13L5	4.00	7.71	57.40	82.20	---	2,880.30	3.71	7.15	53.17	76.20	---	2,668.40	6/86 WES sample[1,3]
14L2	G1SCW14L2R1	4.95	11.69	110.61	1,246.00	---	5,079.23	4.38	10.34	97.87	1,102.60	---	4,494.40	6/86 WES sample[1,3]
	G1SCW14L2R2	4.89	12.05	114.81	1,103.00	---	5,215.50	4.33	10.67	101.59	976.00	---	4,615.00	
	G1SCW14L2R3	4.53	11.73	107.63	1,121.00	---	4,797.70	4.01	10.38	95.24	991.90	---	4,245.30	
14L3	G1SCW14L3	7.26	22.01	153.76	475.60	---	5,633.70	6.39	19.36	135.24	418.30	---	4,955.20	6/86 WES sample[1,3]
13L4	G1SCW13L4	3.50	12.69	40.10	221.90	0.20	2,511.40	---	---	---	---	---	---	1984 WES sample[1,2]
14L1	G1SCW14L1	2.56	9.49	71.79	512.82	---	6,410.30	---	---	---	---	---	---	1985 contractor sample[1,2]
13L1	ESSCW13L1	6.25	26.31	524.48	1,243.91	0.45	15,328.10	---	---	---	---	---	---	1984 WES sample[1,2]
13L6	ESSCW13L6	13.20	1.82	998.04	6,410.50	---	20,539.00	12.97	1.79	981.00	6,301.10	---	20,188.30	6/86 WES sample[1,3]

TABLE 6 (Continued)

REMEDIAL ACTION SUBSITE 3 ACTIVE AREA,
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PREREMEDIATION SURFACE SOIL RESULTS
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	**Sample ID**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Sample Date**
13K2	ESSCW13K2R1	4.94	5.39	60.04	604.30	---	4,534.00	4.79	5.23	58.22	586.00	---	4,396.50	6/86 WES resample[1,3]
	ESSCW13K2R2	4.18	4.76	53.70	390.20	---	2,539.10	4.05	4.62	52.07	378.40	---	2,462.10	
	ESSCW13K2R3	4.78	4.67	54.89	394.60	---	2,490.80	4.64	4.53	53.22	382.70	---	2,415.30	
	Average	**9.39**	**18.69**	**368.05**	**952.99**	**0.28**	**10,667.45**	**7.14**	**12.60**	**228.85**	**763.17**	**NA**	**7,059.78**	
	Standard Deviation	**11.98**	**14.12**	**638.31**	**1,706.44**	**0.42**	**16,525.39**	**6.91**	**8.96**	**351.00**	**1,393.77**	**NA**	**8,971.11**	

Notes:

--- No data were available
ID Identification
mg/kg Milligram per kilogram
NA Not applicable
WES U.S. Army Corps of Engineers, Waterways Experiment Station

References:

1 Cullinane, M.J., Lee, C.R., and O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at Naval Weapons Staion Concord, California, Volume III: Figures." Miscellaneous Paper EL-86-3. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.
2 Lee, C.R., and others. 1986. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.
3 Lee, C.R., and others. 1988. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California, Subtitle Appendix 2.5 - 1986 to 1987 Data." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

TABLE 7

REMEDIAL ACTION SUBSITE 3 ACTIVE AREA,
SURFACE SOIL SAMPLING RESULTS IMMEDIATELY AFTER REMEDIATION
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Sample ID	Mean Concentration of Triplicate Samples[1] (mg/kg dry weight) (n = 3)					
	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc
3A01-140-A1,A2,A3-100394	8.63	6.70	86.07	836.80	0.48	2,946.00
3A02-035-A1,A2,A3-100394	7.47	3.70	51.10	142.33	0.47	1,831.67
3A03-223-A1,A2,A3-100394	3.83	0.95	18.57	20.10	0.48	588.00
3A04-202-A1,A2,A3-100394	9.37	6.47	58.77	231.67	0.48	2,355.67
3A05-035-A1,A2,A3-100494	6.03	2.47	62.47	186.67	0.48	953.33
3A06-035-A1,A2,A3-100394	4.40	1.33	29.03	156.00	0.48	601.00
3A07-140-A1,A2,A3-100394	10.03	28.37	114.77	648.67	0.48	8,393.33
3A08-140-A1,A2,A3-100394	2.50	0.95	12.40	23.43	0.47	586.33
3A09-023-A1,A2,A3-100494	7.37	2.23	44.83	126.13	0.48	1,227.00
3A10-394-A1,A2,A3-100394	2.33	0.68	10.70	11.90	0.47	295.33
3A11-023-A1,A2,A3-100394	4.30	2.53	33.33	113.17	0.47	1,650.00
3A12-023-A1,A2,A3-100494	2.67	2.50	15.47	16.43	0.48	1,593.33
3A13-023-A1,A2,A3-100394	3.70	3.33	28.50	54.27	0.48	2,006.67
3A14-140-A1,A2,A3-100394	3.33	2.90	16.17	24.37	0.49	961.67
3A15-023-A1,A2,A3-100394	3.70	1.28	16.20	26.17	0.49	364.00
3A17-140-A1,A2,A3-100394	11.53	15.70	171.00	624.00	0.78	5,173.33
3A17-140-A5,A6,A7-100394	29.30	23.63	166.00	626.33	0.87	5,866.67
3A18-023-A1,A2,A3-100494	8.03	7.43	114.83	247.67	0.49	3,600.00
3A18-023-A5,A6,A7-100494	6.60	6.67	84.17	142.90	0.49	2,656.67
Grand Mean	**7.11**	**6.31**	**59.70**	**224.16**	**0.52**	**2,297.37**
Standard Deviation	**6.04**	**7.83**	**50.57**	**257.89**	**0.11**	**2,145.38**
SARAC (mg/kg dry weight)	**NA**	**12.70**	**345.00**	**NA**	**NA**	**2,512.00**
TTLC[2] (mg/kg wet weight)	**500.00**	**100.00**	**2,500.00**	**1,000.00**	**100.00**	**5,000.00**

Notes:

1 Engineering-Science, Inc. 1994. "Results of Remedial Action Sub-site 3 Immediately After Remediation-Phase Multi-Parameter Surface Soil Sampling and Analysis, Naval Weapons Station, Concord, California." (Letter report to PRC Environmental Management, Inc.) November 28.

2 *California Code of Regulations.* Title 22, Social Security. Division 4.5, Environmental Health Standards for the Management of Hazardous Waste. Chapter 11, Identification and Listing of Hazardous Waste. Article 3, Characteristics of Hazardous Waste. Section 66261.24, Characteristic of Toxicity.

bgs Below ground surface
NA Not applicable
TTLC Total threshold limit concentration
SARAC Statistically above reference area criteria

TABLE 8

REMEDIAL ACTION SUBSITE 4 ACTIVE AREA,
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PREREMEDIATION SURFACE SOIL RESULTS
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Sample ID	Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						Sample Date
		Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc	
29E12	CPSCW29E12	2.98	1.12	46.28	254.30	0.00	682.80	2.90	1.09	45.16	248.20	0.00	666.20	6/86 WES sample[1,3]
29E11	CPSCW29E11R1	6.38	1.44	43.28	1,461.10	16.07	742.06	6.14	1.38	41.64	1,405.60	15.46	713.90	6/86 WES sample[1,3]
	CPSCW29E11R2	3.09	1.16	54.32	796.20	12.96	755.70	2.97	1.12	52.25	765.90	12.46	727.00	
	CPSCW29E11R3	2.59	1.06	52.72	804.60	16.41	729.40	2.49	1.02	50.72	774.00	15.79	701.60	
29E6	CPSCW29E6	9.81	2.47	45.10	1,661.70	58.75	259.10	9.10	2.30	41.87	1,542.40	54.53	240.50	6/86 WES resample[1,3]
29E2	CPSCW29E2R1	22.42	20.85	38.07	102.70	4.37	313.84	20.67	19.23	35.11	94.70	4.03	289.40	6/86 WES resample[1,3]
	CPSCW29E2R2	23.56	21.83	39.94	58.40	7.95	320.80	21.72	20.13	36.82	53.80	7.33	295.80	
	CPSCW29E2R3	21.80	24.04	40.95	67.00	8.50	335.60	20.10	22.16	37.76	61.80	7.84	309.40	
28E2	CPSCW28E2	6.98	1.63	16.28	13.95	2.33	87.20	---	---	---	---	---	---	1985 contractor sample[1,2]
28E1	CPSCW28E1	28.40	14.81	33.33	24.69	2.47	222.20	---	---	---	---	---	---	1985 contractor sample[1,2]
27E1	CPSCW27E1	8.64	7.23	13.55	108.20	11.85	60.40	7.02	5.87	11.00	87.80	9.62	49.10	6/86 WES resample[1,3]
29E3	CPSCW29E3	28.51	4.29	47.31	242.80	37.69	99.87	26.57	4.00	44.09	226.30	35.12	93.10	6/86 WES resample[1,3]
29E1	CPSCW29E1	55.74	28.78	94.84	43.90	1.72	477.41	46.35	23.93	78.86	36.50		397.00	6/86 WES resample[1,3]
29E5	CPSCW29E5	13.58	3.95	37.04	555.56	41.98	103.70	---	---	---	---	---	---	1985 contractor sample[1,2]
29F1	CPSCW29F1	6.26	25.72	35.07	1,065.20	250.22	62.80	5.02	20.65	28.16	855.30	200.91	50.40	6/86 WES resample[1,3]
29E4	CPSCW29E4	8.43	9.04	72.29	46.99	2.41	89.20	---	---	---	---	---	---	1985 contractor sample[1,2]
29F2	CPSCW29F2	17.44	1.40	31.40	26.74	2.33	67.40	---	---	---	---	---	---	1985 contractor sample[1,2]
30F3	CPSCW30F3	3.86	0.38	24.58	19.90	0.00	80.31	3.64	0.36	23.22	18.80	0.00	75.90	6/86 WES resample[1,3]
29F3	CPSCW29F3R1	2.86	0.41	19.02	80.10	5.42	31.82	2.24	0.32	14.90	62.70	4.25	24.90	6/86 WES resample[1,3]
	CPSCW29F3R2	2.79	0.38	18.10	94.70	8.81	25.14	2.18	0.30	14.18	74.20	6.90	19.70	
	CPSCW29F3R3	4.53	1.04	25.10	247.20	12.63	38.90	3.55	0.81	19.66	193.60	9.89	30.50	
29E8	CPSCW29E8	15.49	6.90	30.99	92.96	---	140.80	---	---	---	---	---	---	1985 contractor sample[1,2]
29E7	CPSCW29E7	6.07	1.52	52.42	668.70	24.75	278.30	5.23	1.31	45.19	576.40	21.34	239.90	6/86 WES resample[1,3]
28F1	CPSCW28F1	62.94	9.89	114.93	7,760.00	227.86	99.20	58.35	9.17	106.55	7,194.50	211.25	92.00	6/86 WES resample[1,3]
26F1	CPSCW26F1	77.70	19.15	178.53	79.30	0.00	234.10	69.41	17.11	159.48	70.80	0.00	209.10	6/86 WES resample[1,3]
26F2	CPSCW26F2	68.10	19.15	195.08	52.70	0.20	261.20	62.85	17.67	180.02	48.70	0.18	241.00	6/86 WES resample[1,3]
26G5	CPSCW26G5	63.05	9.88	140.17	382.40	0.00	201.30	59.67	9.35	132.65	361.90	0.00	190.50	6/86 WES resample[1,3]
26G4	CPSCW26G4	89.62	14.02	71.89	22.50	0.00	266.30	83.72	13.10	67.16	21.00	0.00	248.80	6/86 WES resample[1,3]
26G3	CPSCW26G3	91.13	5.80	94.36	15.60	0.00	177.00	85.75	5.46	88.79	14.70	0.00	166.60	6/86 WES resample[1,3]
26G1	CPSCPCW26G1	89.75	13.60	253.81	25.02	0.00	183.70	---	---	---	---	---	---	1984 WES sample[1,2]

TABLE 8 (Continued)

REMEDIAL ACTION SUBSITE 4 ACTIVE AREA,
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PREREMEDIATION SURFACE SOIL RESULTS
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Total Metals (dry weight basis mg/kg)						Total Metals (wet weight basis mg/kg)						
Location	**Sample ID**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Sample Date**
27G1	CPSCW27G1	6.98	1.05	32.56	84.88	2.33	87.20	---	---	---	---	---	---	1985 contractor sample[1,2]
26G2	CPSCW26G2	36.47	5.76	55.29	23.53	2.35	200.00	---	---	---	---	---	---	1985 contractor sample[1,2]
	Average	**27.75**	**8.74**	**64.02**	**530.74**	**24.59**	**241.09**	**26.42**	**8.60**	**58.92**	**643.03**	**28.04**	**264.01**	
	Standard Deviation	**29.63**	**8.74**	**56.22**	**1,387.51**	**58.97**	**214.84**	**28.98**	**8.54**	**46.04**	**1,495.12**	**59.12**	**230.47**	

Notes:

---	No data were available
ID	Identification
mg/kg	Milligram per kilogram
NA	Not applicable
WES	U.S. Army Corps of Engineers, Waterways Experiment Station

References:

1 Cullinane, M.J., Lee, C.R., and O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at Naval Weapons Staion Concord, California, Volume III: Figures." Miscellaneous Paper EL-86-3. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

2 Lee, C.R., and others. 1986. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

3 Lee, C.R., and others. 1988. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station, Concord, California, Subtitle Appendix 2.5 - 1986 to 1987 Data." Miscellaneous Paper EL-86-2. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

TABLE 9

REMEDIAL ACTION SUBSITE 4 ACTIVE AREA,
SURFACE SOIL SAMPLING RESULTS IMMEDIATELY AFTER REMEDIATION
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Sample ID	Mean Concentration of Triplicate Samples[1] (mg/kg dry weight) (n = 3)					
	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc
4A01-035-A1,A2,A3-080394	31.53	5.23	50.97	586.00	67.17	77.60
4A02-338-A1,A2,A3-080394	44.30	7.27	48.73	541.67	30.63	76.40
4A03-394-A1,A2,A3-080494	13.50	3.03	20.03	1,869.37	45.00	99.77
4A04-023-A1,A2,A3-080394	25.40	7.27	37.37	100.00	12.17	112.10
4A05-394-A1,A2,A3-080394	42.50	4.80	51.07	111.47	3.07	100.67
4A06-140-A1,A2,A3-080494	65.50	6.07	43.43	36.13	0.62	112.17
4A07-023-A1,A2,A3-080494	109.70	5.83	24.03	10.30	0.47	105.23
4A07-023-A5,A6,A7-080494	118.67	6.10	24.87	14.30	0.47	101.83
4A08-062-A1,A2,A3-080394	18.87	2.77	18.93	10.43	0.48	64.13
4A08-062-A5,A6,A7-080394	18.87	2.53	18.37	13.87	0.48	62.30
Grand Mean	**48.88**	**5.09**	**33.78**	**329.35**	**16.06**	**91.22**
Standard Deviation	**37.73**	**1.77**	**13.93**	**584.14**	**23.70**	**19.21**
TTLC[2] (mg/kg wet weight)	**500.00**	**100.00**	**2,500.00**	**1,000.00**	**100.00**	**5,000.00**

Notes:

1 Engineering-Science, Inc. 1994. "Results of Remedial Action Sub-site 3 Immediately After Remediation-Phase Multi-Parameter Surface Soil Sampling and Analysis, Naval Weapons Station, Concord, California." (Letter report to PRC Environmental Management, Inc.) November 28.

2 *California Code of Regulations.* Title 22, Social Security. Division 4.5, Environmental Health Standards for the Management of Hazardous Waste. Chapter 11, Identification and Listing of Hazardous Waste. Article 3, Characteristics of Hazardous Waste. Section 66261.24, Characteristic of Toxicity.

bgs Below ground surface

NA Not applicable

TABLE 10A

INORGANIC ACUTE AMBIENT WATER QUALITY CRITERIA
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	EPA State of California Water Quality Criteria (California Toxics Rule)				EPA National Recommended Water Quality Criteria (EPA 1998, 1999)				Bay Basin Plan Objectives Upstream of San Pablo Bay (RWQCB 1995)		Selected Litigation Area Screening Values[a]	
	Saltwater CMC		Freshwater CMC Based on Hardness = 400 mg CaCO3		Saltwater CMC		Freshwater CMC Based on Hardness = 400 mg CaCO3		Totals Concentrations Based on Hardness = 400 mg CaCO3		Lowest of EPA (2000, 1998)	
Analyte	**Dissolved Metals**	**Total Metals[b]**	**Dissolved Metals**	**Total Metals[b]**	**Dissolved Metals**	**Total Metals[b]**	**Dissolved Metals**	**Total Metals[b]**	**CMC for Surface Waters with Salinities Less Than 5 ppt**	**CMC for Surface Waters with Salinities Greater Than 5 ppt**	**Dissolved Metals**	**Total Metals**
Metals (µg/L)												
Aluminum	NA	NA	NA	NA	NA	NA	NA	750[d]	NA	NA	NA	750[d]
Arsenic	69	69.00	340.00	340.00	69	69	340.00	340.00	360	69	69	69
Cadmium	42	42.25	19.1[c]	21.6[c]	42	42.25	19.1[c]	21.6[c]	18.7[c]	43.00	19.1[c]	21.6[c]
Chromium III	NA	NA	1707.9[c]	5404.6[c]	NA	NA	1773.3[c]	5611.7[c]	NA	NA	1707.9[c]	5404.6[c]
Chromium VI	1100	1,107.75	16.00	16.29	1100	1,107.75	16.00	16.29	16	1100	16.00	16.29
Copper	4.8	5.78	49.6[c]	51.7[c]	4.8[e]	5.78	49.6[c]	51.7[c]	65.4[c]	NA	4.8	5.78
Lead	210	220.82	280.8[c]	476.8[c]	210	220.82	280.8[c]	476.8[c]	476.8[c]	140.00	210	220.82
Mercury	NA	NA	NA	NA	1.8	2.12	1.40	1.65	2.4	2.1	1.40	1.65
Nickel	74	74.75	1512.9[c]	1515.9[c]	74	74.75	1513[c]	1516[c]	4582[c]	140[g]	74	74.75
Selenium	290	290.58	NA	NA	290	290.58	NA[f]	NA[f]	NA	NA	290	290.58
Silver	1.9	2.24	37.4[c]	44.0[c]	1.9	2.24	37.4[c]	44.0[c]	44[g,c]	2.3[g]	1.9	2.24
Zinc	90	95.14	379.3[c]	387.8[c]	90	95.14	379.3[c]	387.8[c]	67.8[c]	170[g]	90	95.10

Notes:

CMC Criteria maximum concentration (short-term concentration acute limit)
CTR California Toxics Rule
EPA U.S. Environmental Protection Agency
NA Not available
NTR National Toxics Rule
RWQCB California Regional Water Quality Control Board
µg/L Micrograms per liter

a Lowest total recoverable concentrations based on either EPA (1998) salt water or fresh water, EPA (1999) salt water or fresh water, or California Toxics Rule (Title 40 *Code of Federal Regulations* Part 131).
EPA. 1998. "Quality Criteria for Water." Office of Water. Washington, DC.
EPA. 1999. "National Recommended Water Quality Criteria – Correction." EPA 822-Z-99-001. Office of Water. April.

b Converted from EPA (1998) dissolved metals criterion using conversion factor.

c Criterion is hardness dependent. This value corresponds to a total hardness of 400 mg/L as $CaCO_3$ in the water body.

d Criterion valid only for water in the pH range of 6.5 to 9.0. Aluminum may be less toxic at high pH and hardness, but the effects are not well quantified at this time.

e When the concentration of issolved organic carbon is elevated, copper is substantially less toxic and use fo water-effect ratios might be appropriate.

f The selenium CMC is dependent of frations of selenite and selenate, which was not measured at the site.

g The instantaneous maximum was used because no 1-hour average was available.

TABLE 10B

INORGANIC CHRONIC AMBIENT WATER QUALITY CRITERIA
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	EPA State of California Water Quality Criteria (California Toxics Rule)				EPA National Recommended Water Quality Criteria (EPA 1998, 1999)				Bay Basin Plan Objectives Upstream of San Pablo Bay (RWQCB 1995)		Selected Litigation Area Screening Values[a]	
	Saltwater CCC		Freshwater CCC Based on Hardness = 400 mg CaCO3		Saltwater CCC		Freshwater CCC Based on Hardness = 400 mg CaCO3		Totals Concentrations Based on Hardness = 400 mg CaCO3		Lowest of EPA (2000, 1998)	
Analyte	**Dissolved Metals**	**Total Metals[b]**	**Dissolved Metals**	**Total Metals[b]**	**Dissolved Metals**	**Total Metals[b]**	**Dissolved Metals**	**Total Metals[b]**	**CCC for Surface Waters with Salinities Less Than 5 ppt**	**CCC for Surface Waters with Salinities Greater Than 5 ppt**	**Dissolved Metals**	**Total Metals**
Metals (µg/L)												
Aluminum	NA	NA	NA	NA	NA	NA	NA	87[c]	NA	NA	NA	87[c]
Arsenic	36	36	150.00	150.00	36	36	150.00	150.00	190	36	36.00	36
Cadmium	9.3	9.36	6.2[d]	7.31	9.3	9.36	6.2[d]	7.31	3.4[d]	9.30	6.2[d]	7.3
Chromium III	NA	NA	554[d]	644.20	NA	NA	230.7[d]	268.22	NA	NA	230.7[d]	268.20
Chromium VI	50	50.35	11.00	11.43	50	50.35	11.00	11.43	11.0[f]	50[f]	11.0	11.4
Copper	3.1	3.73	29.3[d]	30.50	3.1	3.73	29.3[d]	30.50	38.7[d]	NA	3.1	3.7
Lead	8.1	8.52	10.9[d]	18.58	8.1	8.52	10.9[d]	18.58	18.6[d]	5.60	8.1	8.5
Mercury	NA	NA	NA	NA	0.94	1.11	0.77	0.91	0.025	0.025	0.025[i]	0.025[i]
Nickel	8.2	8.28	168[d]	168.54	8.2	8.28	168[d]	168.54	509.4[d]	7.1[h]	8.2	8.3
Selenium	71	71.14	NA	5.0	71	71.14	4.6[j]	5.00	NA	NA	4.60	5.00
Silver	1.9[e]	NA	37.4[d,e]	44[e]	1.9[e]	NA	37.4[d,e]	44[e]	NA	NA	1.9[e]	44[e]
Zinc	81	85.62	382.4[d]	387.83	81	85.62	328.4[d]	387.83	74.8[d]	58[h]	81	85.6

Notes:

CCC Criteria continuous concentration (4-day average concentration chronic limit)
CMC Criteria maximum concentration (short-term concentration acute limit)
CTR California Toxics Rule
EPA U.S. Environmental Protection Agency
NA Not available
NTR National Toxics Rule
µg/L Micrograms per liter
RWQCB CaliforniaRegional Water Quality Control Board

a Lowest total recoverable concentrations based on either EPA (1998) salt water or fresh water, EPA (1999) salt water or fresh water, or California Toxics Rule (Title 40 *Code of Federal Regulations* Part 131).
EPA. 1998. "Quality Criteria for Water." Office of Water. Washington, DC.
EPA. 1999. "National Recommended Water Quality Criteria – Correction." EPA 822-Z-99-001. Office of Water. April.

b Converted from EPA (1998) dissolved metals criterion using conversion factor.

c Criterion valid only for water in the pH range of 6.5 to 9.0. Aluminum may be less toxic at high pH and hardness, but the effects are not well quantified at this time.

d Criterion is hardness dependent. This value corresponds to a total hardness of 400 mg/L as $CaCO_3$ in the water body.

e Because there is no proposed CCC for this chemical, the CMC is shown.

f This limit may be met as total chromium.

g The instantaneous maximum concentration was used because no 4-day average value was available.

h The 24-hour average concentration was used because no 4-day average value was available.

i Bay basin plan criterion for mercury was selected based on the request of the RWQCB.

j Converted from EPA (1999) total metals criterion using conversion factor.

TABLE 11

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal Status	State Status	Habitat	Species Present?[a]
Plants	Mason's Lilaeopsis	*Lilaeopsis masonii*	None	CR CNPS list 1B	Tidal brackish marshes and pilings	O
	Suisun Marsh Aster	*Aster lentus*	None	CNPS list 1B	Marshes	O
	Delta Tule Pea	*Lathyrus jepsonii var. jepsonii*	None	CNPS list 1B	Coastal and estuary marshes	O
	Soft Bird's-Beak	*Cordylanthus mollis* ssp. *mollis*	FE	CR CNPS list 1B	Coastal salt marshes, in the central coast of California	O
Fish	Chinook Salmon-Winter Run	*Oncorhynchus tshawytscha*	FE	CE	Open water; migrates through Suisun Bay	P one juvenile chinook observed (race unknown)
	Delta Smelt	*Hypomesus transpacificus*	FT	CT	Estuaries; tidal sloughs	O
	Longfin Smelt	*Spirinchus thaleichthys*	(FSC)	CSC	Estuaries	O
	Sacramento Splittail	*Pogonichthys macrolepidotus*	FT	CSC	Dead-end sloughs, lower delta	P
Reptiles/ Amphibians	California Tiger Salamander	*Ambystoma californiense*	FC	CSC CP	Widespread in moist or rocky habitats; not likely at Litigation Area	P
	California Red-Legged Frog	*Rana aurora draytonii*	FT	CSC CP (full species)	Riparian and stream habitats; not likely in Litigation Area	P

TABLE 11 (Continued)

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal Status	State Status	Habitat	Species Present?[a]
Reptiles/ Amphibians	Western Pond Turtle	*Clemmys marmorata*	(FSC)	CSC CP	Previous studies documented as occurring in Middle Point and Seal Creek wetlands.	O
	California Silvery Legless Lizard	*Anniella pulchra pulchra*	(FSC) USFS-S	CSC	Not observed, but suitable habitat is available	P
	Giant Garter Snake	*Thamnophis sirtalis tetrataenia*	FT	CP CT	Associated with permanent bodies of water in a variety of habitats	P
Birds	Common Loon	*Gavia immer*	MNBMC	CSC	Estuarine and subtidal marine habitats	P
	American White Pelican	*Pelecanus erythrorhynchos*	None	CSC ACWL	Common on salt ponds of San Francisco Bay	O
	California Brown Pelican	*Pelecanus occidentalis californicus*	FE MNBMC	CE CFP	Estuarine, marine, subtidal, and marine pelagic habitats along California coast	O
	Double-crested Cormorant	*Phalacrocorax auritis*	None	CSC	Found in fresh, salt, and estuarine waters	O
	White-faced Ibis	*Plegadis chihi*	MNBMC	CSC	Found in fresh emergent wetlands and shallow lacustrine waters	O
	Aleutian Canada Goose	*Branta canadensis leucopareia*	FT	None	Seasonal and permanent marshes, palustrine farmed wetlands, reservoirs	P

TABLE 11 (Continued)

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal Status	State Status	Habitat	Species Present?[a]
Birds (Continued)	Barrow's Goldeneye	*Bucephala islandica*	None	CSC ACWL	Found in estuarine and brackish lacustrine waters	O
	Osprey	*Pandion haliaetus*	None	CSC CDF-S	Large fish-bearing waters	P
	White-tailed Kite (formerly black shouldered kite)	*Elanus leucurus* (nesting)	MNBMC	CFP	Coastal and valley lowlands	O
	Bald Eagle	*Haliaeetus leucocephalus*	FPD FT	SE CFP CDF-S	Rare, occasional visitation by migrants	P
	Northern Harrier	*Circus cyaneus*	None	CSC	Fresh and salt water, emergent wetlands	O
	Sharp-shinned Hawk	*Accipiter striatus*	None	CSC	Forages on shorelines	O
	Cooper's Hawk	*Accupter cooperii*	None	CSC	Riparian areas	O
	Swainson's Hawk	*Buteo swainsoni*	None	CT	Open, riparian habitat	P
	Ferruginous Hawk	*Buteo regalis*	(FSC) BLM-S MNBMC	CSC ACWL	Open grassland	P
	Golden Eagle	*Aquila chrysaetos*	BLM-S	CFP CSC CDF-S	Open terrain for hunting	O
	Merlin	*Falco columbaris*	None	CSC	Frequents coastlines, open grasslands, woodlands, wetlands, and edges	O

TABLE 11 (Continued)

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal Status	State Status	Habitat	Species Present?[a]
Birds (Continued)	American Peregrine Falcon	*Falco peregrinus anatum*	~~FE~~ (delisted 8/25/99) MNBMC (full species)	CE CFP CDF-S	Foraging over all wetland types except riparian. Only one sighting.	O
	Prairie Falcon	*Falco mexicanus*	None	CSC ACWL	Associated primarily with perennial grasslands	O
	California Black Rail	*Laterallus jamaicensis coturniculus*	(FSC) MNBMC (full species) PIFWL (full species)	CFP CT ACWL	Tidal salt marshes	O
	California Clapper Rail	*Rallus longirostris obsoletus*	FE	CFP CE	Found in coastal wetlands and brackish areas; occasional transitory individuals observed at Litigation Area	O
	"Coastal" Western Snowy Plover	*Charadrius alexandrinus nivosus*	FT MNBMC (full species) PIFWL (full species)	CSC	Common on sandy marine and estuarine habitats	O
	Long-billed Curlew	*Numenius americanus*	MNBMC PIFWL	CSC ACWL	Winter habitat of large coastal estuaries	O

TABLE 11 (Continued)

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal Status	State Status	Habitat	Species Present?[a]
Birds (Continued)	California Gull	*Larus californicus*	None	CSC	Fresh and saline emergent wetlands	O
	Black Tern	*Childonias niger*	(FSC) MNBMC	CSC	Fairly common on bays, salt ponds, river mouths, and pelagic waters during spring and fall migrations	P
	Short-eared Owl	*Asio flammeus*	MNBMC PIFWL	CSC ACWL	Found in saline and fresh emergent wetlands	O
	Vaux's Swift	*Chaetura vauxi*	MNBMC	CSC ACWL	Winter irregularly in southern coastal lowlands	O
	Willow Flycatcher	*Empidonax traillii*	USFS-S	CE	Found primarily in riparian habitats	O
	California Horned Lark	*Eremophila alpestris actia*	None	CSC	Found in grasslands along coast	O
	Loggerhead Shrike	*Lanius ludovicianus*	(FSC) MNBMC	CSC ACWL	Common resident in lowlands and foothills of California	O
	Yellow Warbler	*Dendroica coronata*	None	CSC	Usually found in riparian deciduous habitats in summer	P

TABLE 11 (Continued)

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal Status	State Status	Habitat	Species Present?[a]
Birds (Continued)	Saltmarsh Common Yellowthroat	*Geothlpyis trichas sinuosa*	(FSC)	CSC	Tidal and diked salt and brackish marshes, freshwater marshes, riparian woodland	O
	Suisun Song Sparrow	*Melospiza melodia maxillaris*	(FSC)	CSC	Brackish marshes	O
	Tricolored Blackbird	*Agelaius tricolor*	(FSC) MNBMC BLM-S	CSC ACWL	At least one breeding colony present in nearby Peyton Slough/Shell Marsh	O
Mammals	Suisun Ornate Shrew	*Sorex ornatus sinuosus*	(FSC)	CSC	Tidal salt and brackish marshes	P
	Salt Marsh Harvest Mouse	*Reithrodontomys raviventris*	FE	CE CFP	Tidal salt marshes, diked seasonal salt marshes, and transitional habitat	O

Notes:

a Species Presence
O Observed during surveys or incidentally during field investigation
P Potentially occurring at or near the Litigation Area

Status:

Species of special conservation status, as registered in the California Department of Fish and Game's Natural Diversity Data Base, are indicated by the following codes:

ACWL Audubon Society California Watch List
BLM-S Bureau of Land Management – Sensitive Species
CDF-S California Department of Forestry and Fire Protection – Sensitive Species
CCT State of California Candidate for Threatened Species

TABLE 11 (Continued)

SPECIAL STATUS SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Notes: (continued)

CE	State of California Endangered Species
CFP	California Department of Fish and Game: Fully Protected
CNPS List-1B	California Native Plant Society Listings
CP	California Department of Fish and Game: Protected
CR	State of California Rare
CSC	California Department of Fish and Game: "Species of Special Concern"
CT	State of California Threatened Species
FC	Federal Candidate
FE	Federal Endangered Species
(FSC)	Federal Special Concern Species (not an "active" term per U.S. Fish and Wildlife Service; provided for informational purposes only)
FT	Federal Threatened Species
MNBMC	U.S. Fish and Wildlife Service: Migratory Nongame Birds of Management Concern
PIFWL	Partners in Flight Watch List
USFS-S	U.S. Forest Service – Sensitive Species

Source:

Hickman, J.C. 1993. *The Jepson Manual*. University of California Press, Berkeley, California.

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Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White. 1990. *California's Wildlife Volume III Mammals.* California Statewide Wildlife Habitat Relationships System, Department of Fish and Game. Sacramento, California.

TABLE 12

THREATENED OR ENDANGERED SPECIES OBSERVED OR POTENTIALLY OCCURRING AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal ESA Status	State ESA Status	Habitat	Species Present?[a]
Plants	Soft Bird's-Beak	*Cordylanthus mollis* ssp. *mollis*	FE	None	Coastal salt marshes, in the central coast of California	O
Fish	Chinook Salmon-Winter Run	*Oncorhynchus tshawytscha*	FE	SE	Open water; migrates through Suisun Bay	P one juvenile chinook observed (race unknown)
	Delta Smelt	*Hypomesus transpacificus*	FT	ST	Estuaries; tidal sloughs	O
	Sacramento Splittail	*Pogonichthys macrolepidotus*	FT	None	Dead-end sloughs, lower delta	P
Reptiles/ Amphibians	California Tiger Salamander	*Ambystoma californiense*	FC	None	Widespread in moist or rocky habitats; not likely at Litigation Area	P
	California Red-Legged Frog	*Rana aurora draytonii*	FT	None	Riparian and stream habitats; not likely in Litigation Area	P
	Giant Garter Snake	*Thamnophis sirtalis tetrataenia*	FT	ST	Associated with permanent bodies of water in a variety of habitats	P
Birds	California Brown Pelican	*Pelecanus occidentalis californicus*	FE	SE	Estuarine, marine, subtidal, and marine pelagic habitats along California coast	O
	Aleutian Canada Goose	*Branta canadensis leucopareia*	FT	None	Seasonal and permanent marshes, palustrine farmed wetlands, reservoirs	P

TABLE 12 (Continued)

THREATENED OR ENDANGERED SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Category	Common Name	Scientific Name	Federal ESA Status	State ESA Status	Habitat	Species Present?[a]
Birds (continued)	Bald Eagle	*Haliaeetus leucocephalus*	FPD FT	SE	Rare, occasional visitation by migrants	P
	Swainson's Hawk	*Buteo swainsoni*	None	ST	Open, riparian habitat	P
	American Peregrine Falcon	*Falco peregrinus anatum*	~~FE~~ (delisted 8/25/99)	SE	Foraging over all wetland types except riparian. Only one sighting.	O
	California Black Rail	*Laterallus jamaicensis coturniculus*	None	ST	Tidal salt marshes	O
	California Clapper Rail	*Rallus longirostris obsoletus*	FE	SE	Found in coastal wetlands and brackish areas; occasional transitory individuals observed at Litigation Area	O
	"Coastal" Western Snowy Plover	*Charadrius alexandrinus nivosus*	FT	None	Common on sandy marine and estuarine habitats	O
	Willow Flycatcher	*Empidonax traillii*	None	SE	Found primarily in riparian habitats	O
Mammals	Salt Marsh Harvest Mouse	*Reithrodontomys raviventris*	FE	SE	Tidal salt marshes, diked seasonal salt marshes, and transitional habitat	O

TABLE 12 (Continued)

THREATENED OR ENDANGERED SPECIES OBSERVED OR POTENTIALLY OCCURING AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

a	Species Presence
O	Observed during surveys or incidentally during field investigation
P	Potentially occurring at or near the Litigation Area (based on California Natural Diversity Database)

Federal Endangered Species Act (ESA) Listing Codes:

FC	Federal candidate species
FE	Federally listed as Endangered
FPD	Federally proposed for delisting
FT	Federally listed as Threatened

California Endangered Species Act (CESA) Listing Codes:

SCT	State candidate for listing as Threatened
SE	State-listed as Endangered
ST	State-listed as Threatened

References:

Hickman, J.C. 1993. *The Jepson Manual*. University of California Press, Berkeley, California.

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TABLE 13

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
2	1 M 12	None	1	20.63	3/3	2.40	3/0	65.73	3/3	60.53	3/3	2.67	3/0	349.67	3/3
	1 M 13	None	1	54.10	3/3	1.60	3/0	69.43	3/3	139.00	3/3	1.73	3/0	132.67	3/3
	1 M 14	R01SS059	1	86.37	3/3	1.53	3/0	91.10	3/3	168.33	3/3	1.77	3/0	138.67	3/3
	1 M 15	None	1	66.70	3/3	1.47	3/0	117.63	3/3	52.07	3/3	1.67	3/0	1,046.00	3/3
	1 M 16	R01SS060	1	69.30	3/3	1.93	3/2	266.67	3/3	125.67	3/3	1.33	3/1	1,111.33	3/3
	1 M 17	None	1	315.00	3/3	2.47	3/3	975.33	3/3	104.30	3/3	3.94	3/1	1,831.67	3/3
	1 M 18	None	1	44.30	3/3	1.83	3/3	244.33	3/3	124.27	3/3	9.13	3/3	1,097.33	3/3
	1 M 19	None	1	99.83	3/3	2.10	3/2	419.67	3/3	91.33	3/3	12.73	3/3	1,053.33	3/3
	1 M 20	None	1	132.33	3/3	1.90	3/3	351.33	3/3	142.33	3/3	9.07	3/3	813.00	3/3
	1 M 21	None	1	39.10	3/3	1.23	3/2	199.33	3/3	87.90	3/3	10.93	3/3	282.00	3/3
	1 M 22	None	1	232.00	3/3	1.29	3/2	395.33	3/3	175.67	3/3	1.20	3/1	237.67	3/3
	1 M 23	R01SS036	1	43.50	3/3	0.88	3/1	84.87	3/3	103.43	3/3	1.04	3/0	325.67	3/3
	1 M 24	None	1	47.97	3/3	1.10	3/2	96.73	3/3	90.33	3/3	1.13	3/0	374.67	3/3
	1 M 25	R01SS022	1	30.50	3/3	0.75	3/1	71.00	3/3	36.23	3/3	0.83	3/0	163.67	3/3
	1 M 26	None	1	12.90	3/3	0.99	3/0	56.97	3/3	46.03	3/3	1.11	3/0	130.70	3/3
	1 M 27	None	1	13.73	3/3	1.33	3/0	65.07	3/3	50.23	3/3	1.43	3/0	129.67	3/3
	1 M 28	None	1	15.13	3/3	1.27	3/1	59.27	3/3	31.33	3/3	1.13	3/1	143.67	3/3
	1 M 29	None	1	21.47	3/3	0.80	3/2	66.60	3/3	45.27	3/3	1.12	3/0	168.67	3/3
	1 M 30	None	1	15.20	3/3	1.54	3/1	65.77	3/3	59.43	3/3	1.04	3/0	191.67	3/3
	1 M 31	None	1	11.07	3/3	1.09	3/1	60.57	3/3	33.50	3/3	1.13	3/0	149.33	3/3
	1 M 32	None	1	12.23	3/3	0.93	3/0	63.87	3/3	36.37	3/3	0.98	3/0	152.00	3/3
	1 M 48	None	1	29.23	3/3	1.33	3/0	87.47	3/3	78.70	3/3	1.47	3/1	243.00	3/3
	1 M 49	None	1	64.10	3/3	1.70	3/3	97.90	3/3	171.00	3/3	1.80	3/2	238.00	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
2	1 M 50	None	1	42.27	3/3	1.80	3/0	93.80	3/3	139.33	3/3	2.03	3/0	169.67	3/3
	1 M 51	R01SS001	1	22.80	3/3	1.70	3/0	59.63	3/3	67.50	3/3	1.80	3/0	138.33	3/3
	1 M 52	None	1	28.17	3/3	1.33	3/1	74.70	3/3	80.57	3/3	1.18	3/0	182.67	3/3
	1 M 53	None	1	18.17	3/3	1.19	3/0	60.73	3/3	98.37	3/3	1.29	3/1	272.67	3/3
	1 M 54	None	1	15.77	3/3	1.57	3/0	70.73	3/3	55.03	3/3	1.80	3/0	213.67	3/3
	1 M 55	R01SS025	1	12.80	3/3	1.27	3/0	65.10	3/3	61.30	3/3	1.37	3/0	400.33	3/3
	1 P 21	None	1	34.67	3/3	1.23	3/1	116.27	3/3	110.30	3/3	1.17	3/0	343.33	3/3
	1 P 22	None	1	15.30	3/3	0.83	3/1	64.63	3/3	39.23	3/3	1.20	3/1	139.00	3/3
	1 P 23	None	1	17.37	3/3	1.23	3/1	57.30	3/3	40.47	3/3	1.33	3/0	141.33	3/3
	1 P 24	None	1	11.70	3/3	1.77	3/3	72.90	3/3	48.70	3/3	1.07	3/0	188.67	3/3
	1 P 25	None	1	12.27	3/3	1.23	3/0	66.33	3/3	34.93	3/3	1.30	3/0	151.67	3/3
Average for Spatial Unit 2				**50.23**		**1.43**		**143.36**		**83.21**		**2.53**		**377.80**	
6	1 M 1	None	1	28.03	3/3	1.97	3/3	216.00	3/3	160.00	3/3	0.51	3/2	528.00	3/3
	1 M 10	None	1	31.20	3/3	1.87	3/0	255.67	3/3	137.00	3/3	2.03	3/0	997.00	3/3
	1 M 11	None	1	458.53	3/3	1.67	3/1	233.33	3/3	169.00	3/3	1.63	3/0	468.00	3/3
	1 M 2	R01SS043	1	197.67	3/3	8.27	3/3	879.00	3/3	245.33	3/3	3.21	3/3	683.00	3/3
	1 M 3	None	1	116.70	3/3	7.80	3/3	745.67	3/3	185.00	3/3	5.69	3/3	1,023.33	3/3
	1 M 39	R01SS125	1	18.37	3/3	1.30	3/0	365.33	3/3	104.67	3/3	1.63	3/1	314.00	3/3
	1 M 4	R01SS138	1	23.63	3/3	1.60	3/3	189.80	3/3	120.80	3/3	0.51	3/0	460.33	3/3
	1 M 5	None	1	364.00	3/3	2.87	3/3	952.00	3/3	216.97	3/3	3.17	3/2	1,303.67	3/3
	1 M 56	None	1	57.27	3/3	1.30	3/1	141.67	3/3	101.30	3/3	1.20	3/0	1,233.33	3/3
	1 M 58	R01SS119	1	50.17	3/3	1.90	3/2	240.67	3/3	79.20	3/3	1.60	3/2	1,646.00	3/3
	1 M 59	None	1	59.77	3/3	2.60	3/3	264.33	3/3	160.00	3/3	2.00	3/0	1,336.67	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
6	1 M 60	None	1	72.47	3/3	1.77	3/0	245.00	3/3	133.27	3/3	1.97	3/0	752.33	3/3
	1 M 61	None	1	68.13	3/3	1.67	3/0	247.67	3/3	137.67	3/3	12.77	3/2	971.00	3/3
	1 M 62	R01SS106	1	155.17	3/3	1.27	3/2	155.43	3/3	81.73	3/3	1.30	3/0	610.67	3/3
	1 M 64	R01SS258	1	230.00	3/3	2.07	3/0	218.67	3/3	153.67	3/3	2.03	3/0	498.33	3/3
	1 M 67	None	1	71.53	3/3	2.23	3/3	259.00	3/3	124.13	3/3	1.47	3/1	953.67	3/3
	1 M 68	None	1	69.50	3/3	10.13	3/3	655.33	3/3	548.33	3/3	0.99	3/1	3,270.00	3/3
	1 M 69	None	1	32.60	3/3	1.33	3/1	138.00	3/3	80.23	3/3	1.33	3/0	915.00	3/3
	1 M 7	None	1	108.63	3/3	1.44	3/3	324.00	3/3	69.00	3/3	0.65	3/0	452.67	3/3
	1 M 8	None	1	230.33	3/3	2.57	3/1	431.33	3/3	536.67	3/3	2.77	3/0	1,239.00	3/3
	1 M 9	None	1	894.67	3/3	1.30	3/2	642.67	3/3	338.67	3/3	1.37	3/0	509.33	3/3
	1 P 1	None	1	14.87	3/3	1.00	3/2	703.43	3/3	138.00	3/3	0.50	3/0	673.43	3/3
	1 P 10	None	1	1,283.33	3/3	2.97	3/3	577.33	3/3	166.00	3/3	8.13	3/3	983.67	3/3
	1 P 11	None	1	2,336.67	3/3	3.73	3/3	528.67	3/3	261.33	3/3	2.47	3/2	555.67	3/3
	1 P 12	None	1	2,170.00	3/3	2.33	3/3	496.33	3/3	242.67	3/3	20.07	3/3	219.00	3/3
	1 P 13	None	1	342.70	3/3	1.69	3/1	112.23	3/3	72.53	3/3	1.33	3/1	192.00	3/3
	1 P 14	None	1	1,138.33	3/3	4.03	3/3	374.00	3/3	119.17	3/3	5.10	3/1	936.33	3/3
	1 P 15	None	1	552.00	3/3	2.87	3/0	197.00	3/3	61.03	3/3	10.17	3/2	1,119.67	3/3
	1 P 16	None	1	372.00	3/3	2.50	3/3	179.33	3/3	82.57	3/3	1.63	3/2	982.33	3/3
	1 P 17	None	1	255.27	3/3	1.40	3/2	447.00	3/3	200.37	3/3	11.50	3/2	213.67	3/3
	1 P 18	None	1	184.60	3/3	2.33	3/1	422.33	3/3	157.07	3/3	2.20	3/0	582.33	3/3
	1 P 19	None	1	73.77	3/3	1.57	3/3	231.50	3/3	90.73	3/3	5.57	3/2	413.33	3/3
	1 P 2	None	1	108.77	3/3	3.50	3/3	817.00	3/3	131.13	3/3	5.73	3/3	675.33	3/3
	1 P 20	R01SS042	1	374.00	3/3	2.17	3/3	595.00	3/3	275.33	3/3	14.63	3/3	276.00	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
6	1 P 3	R01SS128	1	57.70	3/3	4.47	3/3	762.33	3/3	223.33	3/3	0.54	3/2	985.67	3/3
	1 P 4	None	1	836.33	3/3	5.37	3/3	1,563.33	3/3	1,192.67	3/3	11.20	3/3	1,171.67	3/3
	1 P 5	None	1	48.10	3/3	4.47	3/3	132.47	3/3	59.37	3/3	0.67	3/1	513.67	3/3
	1 P 6	None	1	19.37	3/3	1.32	3/2	73.67	3/3	25.17	3/3	0.71	3/0	241.00	3/3
	1 P 63	None	1	426.33	3/3	3.23	3/3	634.00	3/3	131.33	3/3	1.51	3/0	994.00	3/3
	1 P 64	None	1	658.33	3/3	1.87	3/1	445.33	3/3	164.67	3/3	2.13	3/0	375.33	3/3
	1 P 65	R01SS107	1	713.67	3/3	3.50	3/2	791.00	3/3	306.67	3/3	2.90	3/0	826.00	3/3
	1 P 66	None	1	614.67	3/3	1.83	3/1	435.33	3/3	153.00	3/3	2.17	3/0	335.33	3/3
	1 P 67	None	1	64.10	3/3	4.20	3/3	273.33	3/3	62.40	3/3	1.43	3/0	2,506.67	3/3
	1 P 7	None	1	46.90	3/3	1.72	3/3	189.33	3/3	30.00	3/3	2.78	3/1	373.00	3/3
	1 P 8	None	1	481.00	3/3	12.83	3/3	820.33	3/3	148.67	3/3	6.67	3/2	2,886.67	3/3
	1 P 9	None	1	72.13	3/3	3.30	3/3	133.50	3/3	30.60	3/3	0.85	3/0	649.67	3/3
Average for Spatial Unit 6				**360.51**		**3.02**		**429.04**		**182.79**		**3.75**		**866.23**	
12	1 M 6	None	1	441.33	3/3	1.87	3/3	1,048.67	3/3	277.33	3/3	6.55	3/3	322.33	3/3
	2 M 1	None	2	47.73	3/3	10.23	3/3	462.00	3/3	947.00	3/3	1.83	3/0	3,573.33	3/3
	2 M 10	None	2	20.23	3/3	2.97	3/3	249.00	3/3	202.00	3/3	1.22	3/3	1,563.33	3/3
	2 M 11	R02SS268	2	83.60	3/3	12.33	3/3	720.33	3/3	498.33	3/3	2.29	3/1	2,286.67	3/3
	2 M 12	None	2	31.73	3/3	3.17	3/3	239.00	3/3	273.67	3/3	0.54	3/1	893.00	3/3
	2 M 13	R02SS146	2	12.90	3/3	0.82	3/3	32.37	3/3	68.87	3/3	0.51	3/0	227.00	3/3
	2 M 14	None	2	15.60	3/3	1.10	3/3	61.53	3/3	127.00	3/3	1.12	3/2	371.67	3/3
	2 M 15	R02SS151	2	21.07	3/3	1.70	3/3	72.73	3/3	53.50	3/3	0.51	3/1	308.67	3/3
	2 M 16	R02SS136	2	312.00	3/3	22.23	3/3	999.00	3/3	1,852.67	3/3	1.27	3/0	6,393.33	3/3
	2 M 17	None	2	169.33	3/3	8.47	3/3	301.33	3/3	289.00	3/3	1.29	3/0	3,043.33	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
12	2 M 18	None	2	59.53	3/3	8.60	3/3	905.33	3/3	341.00	3/3	2.17	3/1	3,053.33	3/3
	2 M 2	None	2	25.50	3/3	9.63	3/3	415.33	3/3	1,017.33	3/3	1.60	3/0	3,756.67	3/3
	2 M 24	R02SS207	2	16.53	3/3	0.76	3/3	53.17	3/3	97.17	3/3	0.50	3/2	227.00	3/3
	2 M 3	None	2	83.20	3/3	20.60	3/3	181.00	3/3	104.03	3/3	3.82	3/2	3,253.33	3/3
	2 M 4	None	2	38.47	3/3	12.37	3/3	553.33	3/3	476.67	3/3	10.23	3/2	3,120.00	3/3
	2 M 5	None	2	17.00	3/3	21.87	3/3	148.93	3/3	187.67	3/3	0.75	3/0	5,443.33	3/3
	2 M 6	None	2	23.80	3/3	2.73	3/3	262.33	3/3	305.33	3/3	1.83	3/0	2,010.00	3/3
	2 M 7	None	2	93.13	3/3	23.90	3/3	543.33	3/3	430.33	3/3	17.37	3/3	6,810.00	3/3
	2 M 8	None	2	28.47	3/3	2.23	3/3	248.33	3/3	214.67	3/3	1.31	3/0	1,551.33	3/3
	2 M 9	None	2	16.23	3/3	2.43	3/3	119.37	3/3	106.67	3/3	1.53	3/0	1,653.33	3/3
	2 P 1	R02SS135	2	42.13	3/3	11.53	3/3	364.00	3/3	223.13	3/3	0.89	3/1	3,733.33	3/3
	2 P 2	R02SS271	2	31.13	3/3	14.47	3/3	157.33	3/3	126.67	3/3	0.92	3/0	3,043.33	3/3
	2 P 3	None	2	26.90	3/3	8.47	3/3	419.67	3/3	466.67	3/3	1.77	3/2	3,700.00	3/3
	2 P 4	None	2	28.00	3/3	35.60	3/3	83.80	3/3	130.33	3/3	0.62	3/0	6,456.67	3/3
	2 P 5	None	2	73.20	3/3	5.07	3/3	590.67	3/3	210.00	3/3	2.10	3/0	2,940.00	3/3
	2 P 6	None	2	29.00	3/3	1.87	3/2	279.33	3/3	271.00	3/3	1.53	3/0	1,143.33	3/3
	2 P 7	None	2	23.07	3/3	1.97	3/3	283.67	3/3	184.33	3/3	1.40	3/1	1,643.33	3/3
Average for Spatial Unit 12				**67.07**		**9.22**		**362.77**		**351.20**		**2.50**		**2,685.96**	
13	3 M 1	None	3	6.90	3/3	0.49	3/2	21.33	3/3	45.27	3/3	1.11	3/3	136.47	3/3
	3 M 10	None	3	5.93	3/3	6.10	3/3	39.83	3/3	424.67	3/3	0.53	3/0	1,830.00	3/3
	3 M 11	None	3	2.83	3/3	0.77	3/3	24.43	3/3	63.53	3/3	0.40	3/0	285.67	3/3
	3 M 12	None	3	10.63	3/3	7.27	3/3	140.33	3/3	738.33	3/3	0.76	3/1	5,980.00	3/3
	3 M 13	R03SS167	3	12.10	3/3	0.52	3/1	31.33	3/3	52.73	3/3	0.51	3/0	85.80	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
13	3 M 14	None	3	10.23	3/3	0.47	3/1	22.57	3/3	24.83	3/3	0.51	3/1	80.40	3/3
	3 M 15	None	3	11.73	3/3	0.68	3/3	33.87	3/3	51.13	3/3	0.54	3/0	497.67	3/3
	3 M 16	None	3	17.50	3/3	0.65	3/2	93.43	3/3	79.93	3/3	0.63	3/0	188.00	3/3
	3 M 17	None	3	13.90	3/3	0.67	3/0	67.70	3/3	77.33	3/3	0.96	3/3	136.00	3/3
	3 M 18	None	3	6.50	3/3	0.57	3/2	33.27	3/3	45.37	3/3	0.56	3/3	133.90	3/3
	3 M 19	None	3	7.00	3/3	0.71	3/2	23.77	3/3	205.90	3/3	0.52	3/0	338.33	3/3
	3 M 2	None	3	6.03	3/3	0.66	3/3	26.27	3/3	72.23	3/3	0.45	3/0	192.33	3/3
	3 M 20	None	3	5.73	3/3	1.94	3/2	43.30	3/3	159.00	3/3	0.58	3/0	853.33	3/3
	3 M 22	None	3	8.33	3/3	0.57	3/1	24.33	3/3	39.03	3/3	0.51	3/0	114.87	3/3
	3 M 24	None	3	7.13	3/3	5.23	3/3	31.43	3/3	54.30	3/3	0.51	3/0	1,605.67	3/3
	3 M 26	None	3	23.47	3/3	21.40	3/3	668.67	3/3	1,872.33	3/3	1.90	3/2	18,953.33	3/3
	3 M 27	None	3	5.03	3/3	6.47	3/3	152.47	3/3	79.70	3/3	0.56	3/0	2,553.33	3/3
	3 M 29	R03SS163	3	8.63	3/3	7.47	3/3	149.70	3/3	215.70	3/3	0.85	3/2	3,213.33	3/3
	3 M 3	None	3	8.40	3/3	0.63	3/2	22.37	3/3	32.87	3/3	0.66	3/3	117.67	3/3
	3 M 31	None	3	6.30	3/3	0.90	3/2	37.80	3/3	71.60	3/3	0.53	3/0	522.33	3/3
	3 M 33	None	3	809.47	3/3	15.17	3/3	154.67	3/3	43,456.53	3/3	1.01	3/3	3,463.33	3/3
	3 M 4	None	3	5.73	3/3	0.83	3/3	24.23	3/3	78.70	3/3	0.45	3/1	198.00	3/3
	3 M 41	R03WD157	3	11.00	3/3	3.53	3/3	50.87	3/3	45.67	3/3	0.78	3/0	1,454.00	3/3
	3 M 42	None	3	11.33	3/3	0.90	3/3	35.77	3/3	89.73	3/3	0.43	3/0	157.33	3/3
	3 M 5	None	3	6.07	3/3	0.73	3/3	31.10	3/3	82.20	3/3	0.44	3/0	258.67	3/3
	3 M 6	None	3	4.33	3/3	0.59	3/2	19.93	3/3	30.60	3/3	0.50	3/0	149.43	3/3
	3 M 7	None	3	5.13	3/3	0.90	3/3	29.33	3/3	86.57	3/3	0.45	3/0	287.67	3/3
	3 M 8	None	3	5.00	3/3	0.57	3/3	20.30	3/3	28.07	3/3	0.47	3/0	203.67	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
13	3 M 9	None	3	14.90	3/3	12.73	3/3	150.37	3/3	1,418.33	3/3	0.49	3/1	18,233.33	3/3
	3 P 1	None	3	4.67	3/3	0.53	3/3	21.70	3/3	62.57	3/3	0.44	3/0	147.00	3/3
	3 P 2	None	3	8.93	3/3	0.49	3/1	18.63	3/3	27.63	3/3	0.78	3/2	101.03	3/3
	3 P 3	None	3	5.83	3/3	0.71	3/3	21.90	3/3	23.83	3/3	0.46	3/0	216.67	3/3
	3 P 4	None	3	4.70	3/3	1.23	3/3	33.70	3/3	148.67	3/3	0.43	3/0	436.00	3/3
	3 P 5	None	3	9.63	3/3	0.92	3/3	29.07	3/3	84.70	3/3	0.50	3/0	584.33	3/3
	3 P 6	None	3	4.47	3/3	1.07	3/3	30.53	3/3	123.67	3/3	0.43	3/0	434.67	3/3
	3 P 7	None	3	6.17	3/3	0.70	3/3	30.93	3/3	68.20	3/3	0.50	3/0	254.33	3/3
	3 P 8	None	3	11.47	3/3	0.73	3/3	39.67	3/3	92.93	3/3	0.43	3/0	244.33	3/3
	3 P 9	None	3	14.60	3/3	0.85	3/3	49.70	3/3	128.00	3/3	0.49	3/1	228.33	3/3
Average for Spatial Unit 13				**29.68**		**2.83**		**65.28**		**1,328.48**		**0.61**		**1,707.12**	
14	4 M 1	None	4	8.60	3/3	0.99	3/3	54.10	3/3	230.33	3/3	6.93	3/3	469.33	3/3
	4 M 10	None	4	26.10	3/3	5.77	3/3	32.00	3/3	92.63	3/3	5.33	3/3	97.80	3/3
	4 M 11	None	4	9.10	3/3	0.60	3/1	21.37	3/3	42.70	3/3	1.25	3/3	69.50	3/3
	4 M 12	None	4	31.10	3/3	3.07	3/3	39.77	3/3	23.47	3/3	0.51	3/1	177.67	3/3
	4 M 13	None	4	28.30	3/3	3.43	3/3	37.67	3/3	20.23	3/3	0.97	3/3	131.10	3/3
	4 M 14	None	4	34.07	3/3	6.77	3/3	22.10	3/3	17.33	3/3	0.55	3/1	148.33	3/3
	4 M 15	R04SS0191	4	26.30	3/3	3.17	3/3	18.10	3/3	24.30	3/3	0.59	3/2	109.77	3/3
	4 M 16	R04SS0193	4	36.80	3/3	10.67	3/3	30.23	3/3	18.10	3/3	2.26	3/1	223.00	3/3
	4 M 2	None	4	8.00	3/3	1.37	3/3	41.87	3/3	238.00	3/3	5.43	3/3	524.33	3/3
	4 M 23	None	4	9.43	3/3	1.80	3/3	33.03	3/3	61.57	3/3	1.11	3/0	159.33	3/3
	4 M 3	None	4	12.30	3/3	1.40	3/3	42.17	3/3	76.87	3/3	2.51	3/2	181.00	3/3
	4 M 4	None	4	61.47	3/3	7.73	3/3	87.90	3/3	72.33	3/3	7.10	3/3	219.00	3/3

TABLE 13 (Continued)

SUMMARY OF PREREMEDIATION SURFACE SOIL RESULTS[a]
(0 TO 0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
14	4 M 5	None	4	39.43	3/3	9.13	3/3	85.10	3/3	66.47	3/3	2.12	3/3	267.00	3/3
	4 M 6	None	4	30.57	3/3	6.20	3/3	48.83	3/3	47.73	3/3	0.49	3/1	187.67	3/3
	4 M 7	R04SS0198	4	34.47	3/3	5.30	3/3	61.47	3/3	856.00	3/3	132.13	3/3	201.33	3/3
	4 M 8	R04SS192	4	49.60	3/3	2.73	3/3	39.03	3/3	35.87	3/3	2.43	3/3	150.33	3/3
	4 M 9	None	4	25.60	3/3	4.87	3/3	26.57	3/3	40.00	3/3	6.10	3/3	85.43	3/3
	4 P 1	None	4	11.37	3/3	1.66	3/3	61.90	3/3	272.67	3/3	15.87	3/3	529.33	3/3
	4 P 2	None	4	39.30	3/3	7.10	3/3	53.33	3/3	48.13	3/3	1.59	3/2	208.67	3/3
	4 P 3	R04SS196	4	36.93	3/3	11.17	3/3	77.07	3/3	49.80	3/3	0.48	3/0	245.00	3/3
	4 P 4	None	4	82.30	3/3	7.67	3/3	99.10	3/3	2,253.67	3/3	160.67	3/3	173.33	3/3
	4 P 5	None	4	38.13	3/3	9.67	3/3	95.23	3/3	51.87	3/3	0.47	3/0	279.67	3/3
Average for Spatial Unit 14				**30.88**		**5.10**		**50.36**		**210.91**		**16.22**		**219.91**	
16	R1 1	UDRSS001	UDR	5.07	3/3	0.43	3/1	19.63	3/3	29.70	3/3	0.39	3/0	130.27	3/3
	R1 2	UDRSS004	UDR	4.63	3/3	0.66	3/2	22.33	3/3	44.77	3/3	0.40	3/0	110.83	3/3
	R1 3	UDRSS005	UDR	4.63	3/3	0.50	3/3	21.07	3/3	45.43	3/3	0.42	3/0	102.43	3/3
	R1 4	UDRSS007	UDR	4.40	3/3	0.47	3/1	22.40	3/3	41.10	3/3	0.41	3/0	104.23	3/3
Average for Spatial Unit 16				**4.68**		**0.51**		**21.36**		**40.25**		**0.41**		**111.94**	

Notes:

a All results in milligrams per kilogram

b Average of three replicate samples; nondetect results included in average at 1/2 the detection limit

c Number of detected / Number of nondetected results

ID Identification

RASS Remedial action subsite

TABLE 14

SUMMARY OF PREREMEDIATION SEDIMENT RESULTSa
(0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
3	R01DH052	1 M 44	1	79.93	3/3	2.23	3/1	111.83	3/3	49.17	3/3	2.23	3/0	1,303.33	3/3
	R01DH061	1 M 43	1	76.77	3/3	3.37	3/3	141.00	3/3	43.00	3/3	2.03	3/0	992.67	3/3
Average for Spatial Unit 3				**78.35**		**2.80**		**126.42**		**46.08**		**2.13**		**1,148.00**	
7	None	1 P 45	1	367.00	3/3	7.77	3/3	247.67	3/3	79.73	3/3	8.20	3/2	1,110.00	3/3
	R01DH041	1 M 41	1	50.63	3/3	4.20	3/2	184.33	3/3	43.97	3/3	4.27	3/0	1,216.67	3/3
	R01DH067	1 P 46	1	830.33	3/3	9.77	3/3	384.67	3/3	118.10	3/3	2.70	3/2	1,366.67	3/3
	R01DH090	1 M 45	1	42.87	3/3	4.63	3/3	110.33	3/3	53.40	3/3	2.93	3/1	859.67	3/3
	R01DH092	1 P 44	1	191.33	3/3	9.53	3/3	191.33	3/3	56.13	3/3	2.73	3/0	1,215.67	3/3
	R01DH099	1 P 48	1	42.60	3/3	4.33	3/3	110.67	3/3	36.67	3/3	1.87	3/0	805.33	3/3
	R01DH100	1 P 43	1	188.00	3/3	11.97	3/3	247.33	3/3	68.53	3/3	2.43	3/1	1,636.67	3/3
	R01DH113	1 P 68	1	103.03	3/3	7.83	3/3	261.33	3/3	59.53	3/3	2.03	3/0	1,233.33	3/3
	R01DH120	1 M 47	1	176.33	3/3	41.87	3/3	616.00	3/3	87.03	3/3	2.13	3/0	3,970.00	3/3
	R01DH121	1 P 47	1	35.53	3/3	11.23	3/3	159.00	3/3	52.70	3/3	1.50	3/0	2,083.33	3/3
	R01DH241	1 M 42	1	65.57	3/3	4.73	3/3	157.00	3/3	45.53	3/3	2.13	3/0	1,316.67	3/3
Average for Spatial Unit 7				**190.29**		**10.72**		**242.70**		**63.76**		**2.99**		**1,528.55**	
9	R01SH012	1 P 69	1	12.50	3/3	0.86	3/2	47.67	3/3	30.63	3/3	0.79	3/0	117.37	3/3
	R01SH015	1 P 56	1	18.67	3/3	2.97	3/3	110.00	3/3	66.33	3/3	1.01	3/0	683.33	3/3
	R01SH206	1 M 71	1	15.67	3/3	0.92	3/2	35.17	3/3	26.07	3/3	0.75	3/0	130.33	3/3
Average for Spatial Unit 9				**15.61**		**1.58**		**64.28**		**41.01**		**0.85**		**310.34**	
10	R01SH051	1 P 50	1	46.80	3/3	3.03	3/3	203.33	3/3	49.70	3/3	1.10	3/0	603.67	3/3
	R01SH077	1 P 49	1	170.00	3/3	2.77	3/3	118.70	3/3	41.67	3/3	1.33	3/0	543.00	3/3
	R01SH098	1 P 51	1	50.40	3/3	1.41	3/2	67.60	3/3	22.07	3/3	0.96	3/0	234.33	3/3
	R01SH105	1 P 52	1	101.10	3/3	3.77	3/3	88.50	3/3	47.90	3/3	1.03	3/0	776.67	3/3
	R01SH112	1 P 53	1	69.60	3/3	127.67	3/3	310.00	3/3	85.53	3/3	1.63	3/0	11,480.00	3/3
	R01SH132	2 P 08	1	109.47	3/3	8.03	3/3	133.00	3/3	79.27	3/3	1.40	3/0	1,663.33	3/3
	R01SH133	2 P 09	1	11.53	3/3	1.17	3/1	32.33	3/3	11.47	3/3	1.23	3/1	107.27	3/3
Average for Spatial Unit 10				**79.84**		**21.12**		**136.21**		**48.23**		**1.24**		**2,201.18**	

TABLE 14 (Continued)

SUMMARY OF PREREMEDIATION SEDIMENT RESULTSa
(0.5 FOOT BELOW GROUND SURFACE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Spatial Unit	Original Location ID	Near Current Location	RASS	Arsenic		Cadmium		Copper		Lead		Selinium		Zinc	
				Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]	Result[b]	Frequency of Detection[c]
Effects-Range Low				**8.2**		**1.2**		**34.0**		**46.7**		**0.70**		**150**	
Effects-Range Median				**70.0**		**9.6**		**270**		**218**		**1.40**		**410**	
13	R03DH152	3 M 37	3	15.73	3/3	29.47	3/3	35.40	3/3	28.67	3/3	1.11	3/0	424.00	3/3
	R03SH187	3 M 36	3	8.40	3/3	10.00	3/3	100.57	3/3	1,010.33	3/3	0.78	3/3	5,406.67	3/3
	R03SH189	3 M 35	3	8.23	3/3	5.83	3/3	76.20	3/3	437.67	3/3	1.53	3/3	2,930.00	3/3
	R03SH286	3 M 34	3	4.37	3/3	0.85	3/3	28.27	3/3	57.00	3/3	1.37	3/3	288.67	3/3
	UDRSH002	R1 5	UDR	1.90	3/3	0.59	3/0	8.37	3/3	6.20	3/3	0.68	3/0	35.43	3/3
	UDRSH006	R1 6	UDR	2.13	3/3	0.58	3/0	8.73	3/3	6.83	3/3	0.63	3/0	38.33	3/3
Average for Spatial Unit 13				**6.79**		**7.89**		**42.92**		**257.78**		**1.02**		**1,520.52**	
15	R04DH195	4 M 20	4	8.70	3/3	2.80	3/3	67.67	3/3	177.67	3/3	24.73	3/3	450.33	3/3
	R04WD199	4 M 19	4	33.50	3/3	2.63	3/2	68.90	3/3	119.33	3/3	22.10	3/3	528.00	3/3
	R04WD204	4 M 18	4	2.67	3/3	1.07	3/2	27.77	3/3	59.90	3/3	0.88	3/0	180.33	3/3
	R04WD205	4 M 17	4	4.23	3/3	0.94	3/3	28.37	3/3	94.77	3/3	0.80	3/0	183.00	3/3
Average for Spatial Unit 15				**12.28**		**1.86**		**48.18**		**112.92**		**12.13**		**335.42**	

Notes:

a All results in milligrams per kilogram

b Average of three replicate samples; nondetect results included in average at one-half the detection limit

c Number of detected / Number of nondetected results

ID Identification

RASS Remedial action subsite

TABLE 15

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
1	Arsenic	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	5	**5**
		Maximum	14.50	20.80	24.90	48.90	14.30	**24.68**
		Minimum	4.90	4.90	5.60	1.10	3.50	**4.00**
		Average	8.22	10.84	11.70	16.54	7.48	**10.96**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	4	5	5	5	5	**5**
		Number of Detections	0	5	0	4	3	**2**
		Maximum	0.09	1.40	0.08	0.40	0.51	**0.49**
		Minimum	0.03	0.24	0.02	0.02	0.07	**0.07**
		Average	0.05	0.72	0.04	0.12	0.31	**0.25**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	4	**5**
		Maximum	57.40	80.10	88.70	93.90	64.40	**76.90**
		Minimum	8.40	6.70	8.10	9.90	3.85	**7.39**
		Average	26.02	30.86	36.50	54.84	29.27	**35.50**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	5	**5**
		Maximum	58.10	87.00	129.00	78.20	58.80	**82.22**
		Minimum	7.50	9.50	7.20	12.10	6.00	**8.46**
		Average	23.62	27.02	45.76	43.40	25.78	**33.12**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	5	0	0	0	0	**1**
		Number of Detections	3	0	0	0	0	**1**
		Maximum	0.34	0.00	0.00	0.00	0.00	**0.07**
		Minimum	0.01	0.00	0.00	0.00	0.00	**0.00**
		Average	0.13	0.00	0.00	0.00	0.00	**0.03**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	5	5	5	5	5	**5**
		Number of Detections	1	3	2	3	2	**2**
		Maximum	1.60	2.00	3.50	1.80	2.40	**2.26**
		Minimum	0.29	0.27	0.17	0.17	0.14	**0.21**
		Average	0.74	0.91	1.04	1.10	0.92	**0.94**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	5	**5**
		Maximum	111.00	237.00	267.00	226.00	123.00	**192.80**
		Minimum	38.50	36.40	43.20	39.70	27.80	**37.12**
		Average	71.10	112.40	115.38	109.44	69.12	**95.49**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
2	Arsenic	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	75.90	56.10	122.00	92.90	94.40	**88.26**
		Minimum	9.00	13.40	12.00	6.50	9.60	**10.10**
		Average	38.68	24.85	38.63	25.62	25.56	**30.67**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	10	10	10	10	10	**10**
		Number of Detections	0	4	0	8	5	**3**
		Maximum	0.14	1.70	0.11	1.30	1.40	**0.93**
		Minimum	0.05	0.06	0.04	0.05	0.07	**0.05**
		Average	0.08	0.61	0.07	0.60	0.56	**0.38**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	111.00	117.00	179.00	100.00	138.00	**129.00**
		Minimum	53.30	53.60	57.70	54.90	42.20	**52.34**
		Average	75.88	71.69	89.71	68.67	68.61	**74.91**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	232.00	97.10	131.00	95.50	133.00	**137.72**
		Minimum	21.70	26.60	44.20	20.00	17.00	**25.90**
		Average	91.41	52.87	85.12	50.62	55.16	**67.04**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	3	0	0	0	0	**1**
		Number of Detections	3	0	0	0	0	**1**
		Maximum	0.66	0.00	0.00	0.00	0.00	**0.13**
		Minimum	0.30	0.00	0.00	0.00	0.00	**0.06**
		Average	0.47	0.00	0.00	0.00	0.00	**0.09**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	10	10	10	10	10	**10**
		Number of Detections	1	3	3	10	8	**5**
		Maximum	2.35	4.20	1.50	4.80	3.40	**3.25**
		Minimum	0.75	0.40	0.40	1.60	0.55	**0.74**
		Average	1.41	1.52	0.71	2.48	2.17	**1.66**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	341.00	300.00	860.00	715.00	252.00	**493.60**
		Minimum	110.00	119.00	123.00	94.40	60.30	**101.34**
		Average	202.70	189.20	324.30	210.64	144.53	**214.27**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
4	Arsenic	Number of Results	7	13	13	13	13	**12**
		Number of Detections	7	13	13	13	13	**12**
		Maximum	385.00	191.00	66.50	90.80	116.00	**169.86**
		Minimum	31.60	14.20	18.70	11.20	6.60	**16.46**
		Average	105.33	57.50	38.05	34.22	40.18	**55.06**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	6	13	13	13	13	**12**
		Number of Detections	4	11	2	6	8	**6**
		Maximum	4.30	2.80	1.50	0.28	3.30	**2.44**
		Minimum	0.07	0.09	0.04	0.03	0.06	**0.06**
		Average	1.37	1.15	0.22	0.10	0.95	**0.76**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	7	13	13	13	13	**12**
		Number of Detections	7	13	13	13	13	**12**
		Maximum	159.00	146.00	134.00	159.00	174.00	**154.40**
		Minimum	64.60	53.80	32.90	42.80	45.50	**47.92**
		Average	101.14	86.69	80.47	83.27	91.98	**88.71**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	7	13	13	13	13	**12**
		Number of Detections	7	13	13	13	13	**12**
		Maximum	183.00	272.00	277.00	193.00	173.00	**219.60**
		Minimum	63.10	32.00	30.30	36.10	21.70	**36.64**
		Average	102.20	109.10	100.68	93.90	94.32	**100.04**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	6	0	0	0	0	**1**
		Number of Detections	5	0	0	0	0	**1**
		Maximum	0.53	0.00	0.00	0.00	0.00	**0.11**
		Minimum	0.17	0.00	0.00	0.00	0.00	**0.03**
		Average	0.34	0.00	0.00	0.00	0.00	**0.07**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	7	13	13	13	13	**12**
		Number of Detections	1	6	1	13	13	**7**
		Maximum	3.10	3.50	0.94	5.20	3.20	**3.19**
		Minimum	0.70	0.54	0.33	1.20	0.90	**0.73**
		Average	1.62	1.81	0.61	2.87	1.99	**1.78**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	7	13	13	13	13	**12**
		Number of Detections	7	13	13	13	13	**12**
		Maximum	1,970.00	2,150.00	2,170.00	1,670.00	3,380.00	**2,268.00**
		Minimum	179.00	137.00	119.00	141.00	118.00	**138.80**
		Average	785.71	572.23	651.31	602.54	912.38	**704.84**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
6	Arsenic	Number of Results	17	20	20	21	20	**20**
		Number of Detections	17	20	20	21	20	**20**
		Maximum	1,960.00	1,800.00	1,500.00	1,110.00	622.00	**1,398.40**
		Minimum	10.20	12.90	20.50	7.90	12.40	**12.78**
		Average	460.09	314.46	343.44	285.46	190.57	**318.80**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	17	20	20	21	20	**20**
		Number of Detections	4	8	18	18	19	**13**
		Maximum	12.00	10.60	16.40	14.60	5.80	**11.88**
		Minimum	0.03	0.14	0.08	0.04	0.19	**0.10**
		Average	0.93	1.61	4.97	1.55	2.22	**2.25**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	17	20	20	21	20	**20**
		Number of Detections	17	20	20	21	20	**20**
		Maximum	784.00	1,370.00	1,560.00	813.00	1,110.00	**1,127.40**
		Minimum	42.20	45.60	97.90	43.00	57.90	**57.32**
		Average	366.45	292.27	499.85	328.84	255.17	**348.51**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	17	20	20	21	20	**20**
		Number of Detections	17	20	20	21	20	**20**
		Maximum	1,010.00	872.00	312.00	493.00	332.00	**603.80**
		Minimum	11.80	28.20	51.20	30.10	19.10	**28.08**
		Average	194.55	147.18	163.69	127.72	96.11	**145.85**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	8	0	0	0	0	**2**
		Number of Detections	8	0	0	0	0	**2**
		Maximum	0.72	0.00	0.00	0.00	0.00	**0.14**
		Minimum	0.06	0.00	0.00	0.00	0.00	**0.01**
		Average	0.31	0.00	0.00	0.00	0.00	**0.06**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	17	20	20	21	20	**20**
		Number of Detections	8	10	8	21	20	**13**
		Maximum	9.60	7.60	5.50	7.80	6.00	**7.30**
		Minimum	0.43	0.09	0.17	0.47	0.59	**0.35**
		Average	3.19	2.35	1.60	3.22	2.91	**2.65**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	17	20	20	21	20	**20**
		Number of Detections	17	20	20	21	20	**20**
		Maximum	5,790.00	5,410.00	3,980.00	4,940.00	1,990.00	**4,422.00**
		Minimum	116.00	115.00	277.00	128.00	123.00	**151.80**
		Average	694.59	764.05	964.65	830.00	582.75	**767.21**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
8	Arsenic	Number of Results	15	15	15	14	15	**15**
		Number of Detections	15	15	15	14	15	**15**
		Maximum	42.80	42.90	19.80	20.40	73.70	**39.92**
		Minimum	12.90	11.10	13.20	11.60	11.80	**12.12**
		Average	18.31	18.31	15.78	14.53	18.07	**17.00**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	15	15	15	14	15	**15**
		Number of Detections	0	14	0	14	10	**8**
		Maximum	0.07	2.20	0.07	1.90	1.20	**1.09**
		Minimum	0.03	0.13	0.02	0.67	0.18	**0.20**
		Average	0.03	1.43	0.03	0.96	0.60	**0.61**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	15	15	15	14	15	**15**
		Number of Detections	15	15	15	14	15	**15**
		Maximum	264.00	136.00	86.20	118.00	268.00	**174.44**
		Minimum	64.10	57.70	64.50	62.50	70.10	**63.78**
		Average	87.17	78.29	76.13	75.65	88.59	**81.17**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	15	15	15	14	15	**15**
		Number of Detections	15	15	15	14	15	**15**
		Maximum	49.10	44.40	50.10	53.80	69.40	**53.36**
		Minimum	31.60	26.10	27.00	25.80	28.50	**27.80**
		Average	39.74	35.53	38.75	36.64	35.67	**37.27**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Selenium	Number of Results	15	15	15	14	15	**15**
		Number of Detections	0	1	3	5	9	**4**
		Maximum	1.10	3.50	0.50	3.00	2.80	**2.18**
		Minimum	0.41	0.24	0.17	0.41	0.21	**0.29**
		Average	0.52	0.48	0.27	0.87	0.80	**0.59**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	15	15	15	14	15	**15**
		Number of Detections	15	15	15	14	15	**15**
		Maximum	678.00	756.00	288.00	392.00	582.00	**539.20**
		Minimum	145.00	134.00	147.00	120.00	133.00	**135.80**
		Average	204.47	201.47	176.93	179.00	182.47	**188.87**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
12	Arsenic	Number of Results	15	20	20	20	20	**19**
		Number of Detections	15	20	20	20	20	**19**
		Maximum	212.00	137.00	230.00	346.00	528.00	**290.60**
		Minimum	5.00	8.10	6.80	3.90	7.80	**6.32**
		Average	28.77	27.19	34.27	32.78	51.52	**34.90**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	15	20	20	20	20	**19**
		Number of Detections	8	17	15	17	20	**15**
		Maximum	16.10	12.50	38.60	9.20	13.40	**17.96**
		Minimum	0.02	0.02	0.02	0.04	0.65	**0.15**
		Average	3.63	2.85	4.29	1.94	2.93	**3.13**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	15	20	20	20	20	**19**
		Number of Detections	6	4	9	2	4	**5**
		Maximum	355.00	572.00	802.00	894.00	443.00	**613.20**
		Minimum	18.80	26.50	19.20	13.40	29.30	**21.44**
		Average	82.94	116.36	148.73	145.89	102.47	**119.28**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	15	20	20	20	20	**19**
		Number of Detections	82	123	171	213	101	**138**
		Maximum	414.00	724.00	6,060.00	509.00	144.00	**1,570.20**
		Minimum	6.80	6.80	13.40	7.90	7.80	**8.54**
		Average	78.10	118.25	408.33	114.26	45.50	**152.89**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	1	0	0	0	0	**0**
		Number of Detections	1	0	0	0	0	**0**
		Maximum	0.05	0.00	0.00	0.00	0.00	**0.01**
		Minimum	0.05	0.00	0.00	0.00	0.00	**0.01**
		Average	0.05	0.00	0.00	0.00	0.00	**0.01**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	15	20	20	20	20	**19**
		Number of Detections	0	1	7	19	4	**6**
		Maximum	0.50	0.97	3.70	5.80	1.30	**2.45**
		Minimum	0.25	0.04	0.16	0.11	0.16	**0.14**
		Average	0.40	0.23	0.50	1.43	0.43	**0.60**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	15	20	20	20	20	**19**
		Number of Detections	15	20	20	20	20	**19**
		Maximum	4,140.00	4,980.00	10,800.00	3,980.00	2,680.00	**5,316.00**
		Minimum	58.50	55.00	51.60	31.20	74.90	**54.24**
		Average	872.70	787.64	1,445.78	806.81	546.60	**891.90**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
14	Arsenic	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	94.60	206.00	120.00	84.30	143.00	**129.58**
		Minimum	3.50	13.40	23.60	4.00	6.80	**10.26**
		Average	40.50	59.65	61.79	38.99	48.49	**49.88**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	10	10	10	10	10	**10**
		Number of Detections	8	10	10	10	10	**10**
		Maximum	11.70	22.10	14.40	10.00	17.90	**15.22**
		Minimum	0.02	0.81	2.60	0.13	0.72	**0.86**
		Average	4.71	6.86	7.04	4.32	5.61	**5.71**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	9	10	10	**10**
		Maximum	86.90	127.00	143.00	164.00	159.00	**135.98**
		Minimum	8.70	18.10	0.08	21.40	17.00	**13.06**
		Average	32.61	50.71	53.58	49.92	53.29	**48.02**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	400.00	1,030.00	5,980.00	631.00	1,880.00	**1,984.20**
		Minimum	6.70	13.30	11.20	10.60	6.80	**9.72**
		Average	85.82	235.26	939.54	162.81	375.35	**359.76**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	1	10	10	10	10	**8**
		Number of Detections	1	5	5	9	10	**6**
		Maximum	4.90	44.40	18.00	12.40	143.00	**44.54**
		Minimum	4.90	0.02	0.03	0.02	0.03	**1.00**
		Average	4.90	10.16	3.47	2.72	16.41	**7.53**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	10	10	10	10	10	**10**
		Number of Detections	3	5	5	10	10	**7**
		Maximum	36.00	71.70	657.00	53.60	109.00	**185.46**
		Minimum	0.36	0.19	0.16	0.81	0.25	**0.35**
		Average	6.77	16.37	125.03	9.52	17.78	**35.09**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	232.00	431.00	572.00	180.00	227.00	**328.40**
		Minimum	21.90	81.50	63.80	40.80	43.80	**50.36**
		Average	126.75	187.35	205.04	114.88	113.00	**149.40**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 15 (Continued)

AVERAGE CONCENTRATIONS IN SURFACE SOIL FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
16	Arsenic	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	4	4	5	**5**
		Maximum	5.30	6.10	7.60	6.30	4.80	**6.02**
		Minimum	5.00	4.10	0.10	0.60	3.00	**2.56**
		Average	5.12	5.12	4.62	3.36	4.02	**4.45**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	5	5	5	5	5	**5**
		Number of Detections	0	2	0	4	5	**2**
		Maximum	0.02	0.17	0.03	0.46	0.63	**0.26**
		Minimum	0.02	0.03	0.02	0.02	0.03	**0.02**
		Average	0.02	0.07	0.02	0.28	0.35	**0.15**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	5	**5**
		Maximum	18.60	21.30	20.70	22.60	24.90	**21.62**
		Minimum	16.10	16.00	9.30	6.00	19.20	**13.32**
		Average	17.40	18.12	18.06	17.42	21.74	**18.55**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	5	**5**
		Maximum	34.10	40.20	65.50	42.00	51.60	**46.68**
		Minimum	13.50	10.00	6.90	3.80	12.50	**9.34**
		Average	24.80	22.46	35.30	20.50	35.40	**27.69**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	5	0	0	5	5	**3**
		Number of Detections	4	0	0	4	5	**3**
		Maximum	0.11	0.00	0.00	0.09	0.08	**0.06**
		Minimum	0.03	0.00	0.00	0.02	0.05	**0.02**
		Average	0.06	0.00	0.00	0.04	0.06	**0.03**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	5	5	5	5	5	**5**
		Number of Detections	0	4	0	2	5	**2**
		Maximum	0.41	1.20	0.26	0.39	0.90	**0.63**
		Minimum	0.35	0.21	0.16	0.10	0.13	**0.19**
		Average	0.37	0.71	0.18	0.19	0.34	**0.36**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	5	5	5	5	5	**5**
		Number of Detections	5	5	5	5	5	**5**
		Maximum	101.00	113.00	132.00	109.00	102.00	**111.40**
		Minimum	47.30	41.00	27.50	17.40	63.80	**39.40**
		Average	68.14	72.14	91.40	61.68	85.26	**75.72**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

Notes: Nondetected results included in average at 1/2 the detection limit
a All maximum, minimum, and average results in milligrams per kilogram
ER-L Effects-range low
ER-M Effects-range median
NA Not applicable
UCL Upper confidence limit

TABLE 16

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
3	Arsenic	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	50.30	100.00	88.90	54.70	49.50	**68.68**
		Minimum	10.90	18.90	11.30	11.40	10.90	**12.68**
		Average	23.60	38.93	31.75	23.17	23.37	**28.16**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	10	10	10	10	10	**10**
		Number of Detections	7	3	5	10	10	**7**
		Maximum	2.10	2.10	8.80	3.70	3.70	**4.08**
		Minimum	0.06	0.05	0.07	0.50	0.57	**0.25**
		Average	0.97	0.56	2.21	1.43	2.18	**1.47**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	130.00	116.00	290.00	116.00	133.00	**157.00**
		Minimum	24.50	53.20	57.60	36.80	66.80	**47.78**
		Average	82.70	70.92	115.97	76.62	96.03	**88.45**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	85.70	122.00	112.00	63.60	49.40	**86.54**
		Minimum	6.70	13.40	30.30	9.30	25.20	**16.98**
		Average	40.30	55.29	64.16	41.52	36.04	**47.46**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	8	0	0	0	0	**2**
		Number of Detections	5	0	0	0	0	**1**
		Maximum	0.58	0.00	0.00	0.00	0.00	**0.12**
		Minimum	0.04	0.00	0.00	0.00	0.00	**0.01**
		Average	0.27	0.00	0.00	0.00	0.00	**0.05**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	10	10	10	10	10	**10**
		Number of Detections	1	5	1	10	8	**5**
		Maximum	7.50	2.70	4.00	5.00	5.00	**4.84**
		Minimum	0.90	0.40	0.50	1.70	0.80	**0.86**
		Average	2.12	1.30	1.20	3.12	2.19	**1.98**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	10	10	10	10	10	**10**
		Number of Detections	10	10	10	10	10	**10**
		Maximum	1,220.00	1,240.00	2,750.00	1,140.00	1,130.00	**1,496.00**
		Minimum	118.00	118.00	99.80	129.00	201.00	**133.16**
		Average	525.00	322.50	719.58	373.20	463.80	**480.82**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
5	Arsenic	Number of Results	6	6	6	6	6	**6**
		Number of Detections	6	6	6	6	6	**6**
		Maximum	93.90	106.00	68.80	101.00	63.50	**86.64**
		Minimum	21.80	19.90	8.60	14.50	4.80	**13.92**
		Average	53.37	45.13	31.60	38.42	31.48	**40.00**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	6	6	6	6	6	**6**
		Number of Detections	4	6	4	6	5	**5**
		Maximum	8.90	6.60	21.40	4.30	4.00	**9.04**
		Minimum	0.13	0.60	0.09	0.17	0.21	**0.24**
		Average	4.75	2.33	5.97	1.76	1.94	**3.35**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	6	6	6	6	6	**6**
		Number of Detections	6	6	6	6	6	**6**
		Maximum	121.00	129.00	275.00	114.00	104.00	**148.60**
		Minimum	21.40	87.20	30.80	16.00	25.30	**36.14**
		Average	81.25	105.83	92.12	70.98	56.68	**81.37**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	6	6	6	6	6	**6**
		Number of Detections	6	6	6	6	6	**6**
		Maximum	102.00	266.00	125.00	62.40	54.20	**121.92**
		Minimum	10.50	60.50	8.80	8.20	6.60	**18.92**
		Average	61.65	106.12	46.58	43.65	27.12	**57.02**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	6	0	0	0	0	**1**
		Number of Detections	1	0	0	0	0	**0**
		Maximum	0.29	0.00	0.00	0.00	0.00	**0.06**
		Minimum	0.06	0.00	0.00	0.00	0.00	**0.01**
		Average	0.16	0.00	0.00	0.00	0.00	**0.03**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	6	6	6	6	6	**6**
		Number of Detections	0	4	0	6	4	**3**
		Maximum	3.10	4.00	1.60	6.60	3.20	**3.70**
		Minimum	1.25	0.88	0.70	2.20	0.90	**1.19**
		Average	2.03	2.10	1.02	3.25	2.10	**2.10**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	6	6	6	6	6	**6**
		Number of Detections	6	6	6	6	6	**6**
		Maximum	2,080.00	2,650.00	3,300.00	1,260.00	887.00	**2,035.40**
		Minimum	259.00	476.00	165.00	74.40	77.60	**210.40**
		Average	1,341.00	1,208.00	932.83	820.23	479.43	**956.30**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
7	Arsenic	Number of Results	9	20	20	20	20	**18**
		Number of Detections	9	20	20	20	20	**18**
		Maximum	1,110.00	3,260.00	1,110.00	706.00	1,000.00	**1,437.20**
		Minimum	39.50	38.60	32.00	32.40	44.30	**37.36**
		Average	229.62	461.55	268.47	188.12	203.27	**270.21**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**
	Cadmium	Number of Results	9	20	20	20	20	**18**
		Number of Detections	9	7	19	17	19	**14**
		Maximum	16.50	8.40	148.00	109.00	94.60	**75.30**
		Minimum	3.10	0.09	0.09	0.06	0.46	**0.76**
		Average	6.48	1.28	15.70	10.36	12.58	**9.28**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	9	20	20	20	20	**18**
		Number of Detections	9	20	20	20	20	**18**
		Maximum	569.00	1,400.00	1,540.00	1,420.00	1,410.00	**1,267.80**
		Minimum	110.00	44.70	49.90	71.60	113.00	**77.84**
		Average	266.33	433.09	386.29	302.99	334.55	**344.65**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	9	20	20	20	20	**18**
		Number of Detections	9	20	20	20	20	**18**
		Maximum	168.00	444.00	475.00	175.00	134.00	**279.20**
		Minimum	36.60	15.00	5.30	27.90	36.70	**24.30**
		Average	70.14	129.57	104.98	74.19	66.12	**89.00**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Selenium	Number of Results	9	20	20	20	20	**18**
		Number of Detections	0	10	10	20	20	**12**
		Maximum	3.10	7.60	7.20	6.50	5.70	**6.02**
		Minimum	1.20	0.60	0.38	1.40	2.20	**1.16**
		Average	1.94	2.61	2.24	3.78	3.34	**2.78**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	9	20	20	20	20	**18**
		Number of Detections	9	20	20	20	20	**18**
		Maximum	2,040.00	2,600.00	11,700.00	8,070.00	7,950.00	**6,472.00**
		Minimum	802.00	158.00	203.00	169.00	209.00	**308.20**
		Average	1,363.11	1,057.05	1,913.15	1,326.05	1,692.55	**1,470.38**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**
9	Arsenic	Number of Results	6	20	21	21	21	**18**
		Number of Detections	6	20	21	21	21	**18**
		Maximum	94.20	46.10	98.10	81.80	46.40	**73.32**
		Minimum	18.80	7.00	9.80	5.80	2.70	**8.82**
		Average	45.70	23.09	34.35	26.13	18.73	**29.60**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
0	Cadmium	Number of Results	6	20	21	21	21	**18**
		Number of Detections	3	13	11	18	15	**12**
		Maximum	1.00	5.80	7.40	1.80	7.30	**4.66**
		Minimum	0.00	0.05	0.04	0.03	0.06	**0.03**
		Average	0.35	0.74	1.49	0.38	1.20	**0.83**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	6	20	21	21	21	**18**
		Number of Detections	6	20	20	21	21	**18**
		Maximum	85.20	92.80	392.00	126.00	128.00	**164.80**
		Minimum	56.10	25.80	0.35	20.20	22.30	**24.95**
		Average	77.07	69.78	105.28	60.38	66.66	**75.83**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	6	20	21	21	21	**18**
		Number of Detections	6	20	21	21	21	**18**
		Maximum	36.40	61.80	147.00	42.20	56.10	**68.70**
		Minimum	20.60	6.00	4.70	6.10	6.50	**8.78**
		Average	31.65	26.82	47.09	19.55	22.06	**29.43**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	5	0	0	0	0	**1**
		Number of Detections	5	0	0	0	0	**1**
		Maximum	0.87	0.00	0.00	0.00	0.00	**0.17**
		Minimum	0.29	0.00	0.00	0.00	0.00	**0.06**
		Average	0.55	0.00	0.00	0.00	0.00	**0.11**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	6	20	21	21	21	**18**
		Number of Detections	0	12	9	20	17	**12**
		Maximum	1.05	6.10	3.70	3.30	2.90	**3.41**
		Minimum	0.00	0.33	0.31	0.50	0.27	**0.28**
		Average	0.68	1.49	1.36	2.03	1.48	**1.41**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	6	20	21	21	21	**18**
		Number of Detections	6	20	21	21	21	**18**
		Maximum	386.00	745.00	1,860.00	690.00	628.00	**861.80**
		Minimum	203.00	22.80	49.80	45.10	47.80	**73.70**
		Average	298.17	265.70	445.70	210.19	188.13	**281.58**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**
10	Arsenic	Number of Results	17	22	22	22	22	**21**
		Number of Detections	17	22	22	22	22	**21**
		Maximum	487.00	331.00	204.00	1,060.00	228.00	**462.00**
		Minimum	35.30	10.90	3.60	15.10	10.30	**15.04**
		Average	92.75	49.87	69.08	146.75	53.90	**82.47**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
10	Cadmium	Number of Results	17	22	22	22	22	**21**
		Number of Detections	16	14	17	21	21	**18**
		Maximum	63.80	10.20	40.40	21.50	124.00	**51.98**
		Minimum	0.06	0.04	0.04	0.05	0.04	**0.05**
		Average	16.57	2.27	4.91	5.68	14.91	**8.87**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	17	22	22	22	22	**21**
		Number of Detections	17	22	22	22	22	**21**
		Maximum	586.00	161.00	351.00	689.00	518.00	**461.00**
		Minimum	69.50	33.50	14.20	38.50	33.40	**37.82**
		Average	212.74	90.22	120.80	145.44	145.65	**142.97**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	17	22	22	22	22	**21**
		Number of Detections	17	22	22	22	22	**21**
		Maximum	231.00	111.00	121.00	94.00	209.00	**153.20**
		Minimum	23.50	8.40	1.70	9.10	8.60	**10.26**
		Average	73.49	38.52	49.26	45.07	44.97	**50.26**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	10	0	0	0	0	**2**
		Number of Detections	10	0	0	0	0	**2**
		Maximum	0.67	0.00	0.00	0.00	0.00	**0.13**
		Minimum	0.35	0.00	0.00	0.00	0.00	**0.07**
		Average	0.49	0.00	0.00	0.00	0.00	**0.10**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	17	22	22	22	22	**21**
		Number of Detections	6	15	10	22	16	**14**
		Maximum	3.60	3.70	6.10	4.80	3.30	**4.30**
		Minimum	0.44	0.34	0.28	0.88	0.41	**0.47**
		Average	1.58	1.79	2.06	2.80	1.66	**1.98**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	17	22	22	22	22	**21**
		Number of Detections	17	22	21	22	22	**21**
		Maximum	6,480.00	3,580.00	12,400.00	3,380.00	9,500.00	**7,068.00**
		Minimum	182.00	69.80	0.13	69.40	68.60	**77.99**
		Average	2,664.18	781.26	1,389.21	1,240.28	1,862.08	**1,587.40**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**
11	Arsenic	Number of Results	4	11	12	12	12	**10**
		Number of Detections	4	11	12	12	12	**10**
		Maximum	131.00	281.00	375.00	508.00	84.20	**275.84**
		Minimum	30.00	18.90	13.60	12.60	30.60	**21.14**
		Average	71.75	81.61	153.99	142.50	59.38	**101.85**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
11	Cadmium	Number of Results	4	11	12	12	12	**10**
		Number of Detections	3	11	10	11	12	**9**
		Maximum	13.90	26.10	832.00	108.00	111.00	**218.20**
		Minimum	0.08	0.63	0.05	0.03	2.40	**0.64**
		Average	5.90	4.13	111.87	22.13	26.53	**34.11**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	4	11	12	12	12	**10**
		Number of Detections	4	11	12	12	12	**10**
		Maximum	165.00	208.00	1,140.00	423.00	253.00	**437.80**
		Minimum	61.40	53.80	24.90	45.10	42.70	**45.58**
		Average	114.70	106.22	250.89	140.03	134.28	**149.22**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	4	11	12	12	12	**10**
		Number of Detections	4	11	12	12	12	**10**
		Maximum	72.40	128.00	331.00	112.00	64.60	**141.60**
		Minimum	22.20	24.90	7.60	11.80	14.50	**16.20**
		Average	49.15	53.89	93.91	53.82	45.42	**59.24**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	4	0	0	0	0	**1**
		Number of Detections	2	0	0	0	0	**0**
		Maximum	0.35	0.00	0.00	0.00	0.00	**0.07**
		Minimum	0.04	0.00	0.00	0.00	0.00	**0.01**
		Average	0.19	0.00	0.00	0.00	0.00	**0.04**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	4	11	12	12	12	**10**
		Number of Detections	2	8	4	12	12	**8**
		Maximum	2.50	6.50	7.00	3.30	4.00	**4.66**
		Minimum	1.30	0.66	0.36	1.50	1.40	**1.04**
		Average	1.84	2.58	2.09	2.38	2.23	**2.22**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	4	11	12	12	12	**10**
		Number of Detections	4	11	12	12	12	**10**
		Maximum	4,210.00	5,560.00	89,300.00	15,000.00	19,500.00	**26,714.00**
		Minimum	953.00	440.00	97.40	381.00	434.00	**461.08**
		Average	2,465.75	1,657.64	13,143.03	3,927.00	4,236.33	**5,085.95**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**
13	Arsenic	Number of Results	10	38	38	38	38	**32**
		Number of Detections	10	34	38	37	31	**30**
		Maximum	22.90	179.00	190.00	37.90	17.50	**89.46**
		Minimum	3.40	0.45	2.40	1.05	0.60	**1.58**
		Average	9.47	18.81	13.44	6.19	4.87	**10.55**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
13	Cadmium	Number of Results	10	38	38	38	38	**32**
		Number of Detections	8	26	25	36	34	**26**
		Maximum	6.90	17.60	55.70	17.60	15.80	**22.72**
		Minimum	0.04	0.04	0.02	0.02	0.03	**0.03**
		Average	2.35	3.46	4.73	1.74	3.00	**3.05**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	10	38	38	38	38	**32**
		Number of Detections	10	38	27	38	38	**30**
		Maximum	61.10	285.00	327.00	137.00	104.00	**182.82**
		Minimum	5.90	8.60	0.08	6.10	10.30	**6.20**
		Average	36.74	56.11	48.16	33.17	30.14	**40.87**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	10	38	38	38	38	**32**
		Number of Detections	9	38	38	38	38	**32**
		Maximum	148.00	2,610.00	2,990.00	951.00	188.00	**1,377.40**
		Minimum	0.23	5.60	6.10	3.60	6.80	**4.47**
		Average	44.46	160.65	164.20	62.27	46.66	**95.65**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	5	0	0	0	0	**1**
		Number of Detections	1	0	0	0	0	**0**
		Maximum	0.06	0.00	0.00	0.00	0.00	**0.01**
		Minimum	0.02	0.00	0.00	0.00	0.00	**0.00**
		Average	0.04	0.00	0.00	0.00	0.00	**0.01**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	10	38	38	38	38	**32**
		Number of Detections	4	8	3	34	20	**14**
		Maximum	1.50	3.20	0.81	2.20	2.50	**2.04**
		Minimum	0.35	0.19	0.16	0.11	0.12	**0.18**
		Average	0.74	0.48	0.26	0.85	0.74	**0.61**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	10	38	38	38	38	**32**
		Number of Detections	10	38	38	38	38	**32**
		Maximum	2,490.00	16,800.00	23,100.00	6,620.00	4,990.00	**10,800.00**
		Minimum	29.30	29.10	34.00	15.70	29.00	**27.42**
		Average	1,254.97	1,958.91	2,053.16	1,073.65	1,419.94	**1,552.13**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**
15	Arsenic	Number of Results	4	5	5	5	5	**5**
		Number of Detections	4	5	5	5	5	**5**
		Maximum	11.60	19.00	13.20	10.40	11.30	**13.10**
		Minimum	3.80	8.80	5.50	4.00	5.20	**5.46**
		Average	8.05	13.18	10.14	6.78	7.90	**9.21**
		ER-L \ ER-M	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	8.2 / 70	**NA**

TABLE 16 (Continued)

AVERAGE CONCENTRATION IN SEDIMENT FOR POSTREMEDIATION MONITORING[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Analyte	Summary Statistics	Year 1	Year 2	Year 3	Year 4	Year 5	Five-year Average
15	Cadmium	Number of Results	4	5	5	5	5	**5**
		Number of Detections	0	4	1	5	5	**3**
		Maximum	0.06	5.80	1.50	1.90	1.80	**2.21**
		Minimum	0.02	0.08	0.03	0.07	0.46	**0.13**
		Average	0.04	1.56	0.33	0.44	1.02	**0.68**
		ER-L \ ER-M	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	1.2 / 9.6	**NA**
	Copper	Number of Results	4	5	5	5	5	**5**
		Number of Detections	4	5	5	5	5	**5**
		Maximum	93.00	76.90	56.80	68.60	56.30	**70.32**
		Minimum	16.00	28.40	21.80	30.00	39.10	**27.06**
		Average	49.13	50.38	40.46	45.28	47.06	**46.46**
		ER-L \ ER-M	34 / 270	34 / 270	34 / 270	34 / 270	34 / 270	**NA**
	Lead	Number of Results	4	5	5	5	5	**5**
		Number of Detections	3	5	5	5	5	**5**
		Maximum	39.20	93.00	413.00	183.00	79.70	**161.58**
		Minimum	0.32	17.60	23.60	35.10	22.30	**19.78**
		Average	23.98	43.90	106.92	69.00	44.40	**57.64**
		ER-L \ ER-M	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	46.7 / 218	**NA**
	Mercury	Number of Results	3	5	5	5	5	**5**
		Number of Detections	3	4	4	5	5	**4**
		Maximum	0.29	0.68	1.00	0.67	0.31	**0.59**
		Minimum	0.11	0.05	0.05	0.14	0.06	**0.08**
		Average	0.19	0.24	0.32	0.26	0.21	**0.24**
		ER-L \ ER-M	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	0.15 / 0.71	**NA**
	Selenium	Number of Results	4	5	5	5	5	**5**
		Number of Detections	1	5	2	5	5	**4**
		Maximum	1.60	4.10	16.00	5.80	6.10	**6.72**
		Minimum	0.37	1.10	0.24	2.00	0.48	**0.84**
		Average	0.88	2.10	4.03	3.26	2.04	**2.46**
		ER-L \ ER-M	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	0.7 / 1.4	**NA**
	Zinc	Number of Results	4	5	5	5	5	**5**
		Number of Detections	4	5	5	5	5	**5**
		Maximum	255.00	289.00	327.00	380.00	293.00	**308.80**
		Minimum	103.00	120.00	100.00	124.00	144.00	**118.20**
		Average	180.00	206.40	202.20	253.80	215.20	**211.52**
		ER-L \ ER-M	150 / 410	150 / 410	150 / 410	150 / 410	150 / 410	**NA**

Notes: Nondetected results included in average at one-half the detection limit
a All maximum, minimum, and average results in milligrams per kilogram
ER-L Effects-range low
ER-M Effects-range median
NA Not applicable
UCL Upper confidence limit

TABLE 17

COMPARISON OF PREREMEDIATION AND POSTREMEDIATION AVERAGE METALS CONCENTRATIONS IN SURFACE SOIL[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Monitoring Period	Number of Results	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
			Average[b]	SD	Average[b]	SD	Average[b]	SD	Average[b]	SD	Average[b]	SD	Average[b]	SD
Effects-range low			**8.20**		**1.20**		**34.00**		**46.70**		**0.70**		**150.00**	
Effects-range median			**70.00**		**9.60**		**270.00**		**218.00**		**1.40**		**410.00**	
Spatial Unit 2 Northern Marsh Soil	Preremediation	34	50.20	64.10	1.43	0.43	143.40	177.00	83.20	43.70	2.53	3.00	377.80	398.00
	Postremediation[c]	50	30.70	25.90	0.38	0.43	74.90	25.60	67.00	42.50	1.70	1.10	214.00	151.00
Spatial Unit 6 Central Marsh Soil	Preremediation	46	360.50	511.00	3.02	2.40	429.00	296.00	182.80	187.00	3.75	4.30	866.20	647.00
	Postremediation[c]	99	319.00	397.00	2.30	3.50	349.00	314.00	146.00	140.00	2.70	1.90	767.00	969.00
Spatial Unit 12 Southern Upland Soil	Preremediation	27	67.10	97.10	9.22	8.90	362.80	287.00	351.20	381.00	2.50	3.60	2,686.00	1,933.00
	Postremediation[c]	95	34.90	70.90	3.10	5.30	119.30	148.00	153.00	626.00	0.60	0.80	892.00	1,592.00
Spatial Unit 14 RASS 4 Upland Soil	Preremediation	22	30.90	18.20	5.10	3.30	50.40	24.70	210.90	491.00	16.22	42.50	219.90	130.00
	Postremediation[c]	50	49.90	39.50	5.70	4.50	48.00	36.30	360.00	924.00	35.10	114.00	149.00	95.10
Spatial Unit 16 Upland Reference Area	Preremediation	4	4.70	0.28	0.51	0.10	21.40	1.30	40.30	7.30	0.41	0.01	111.90	12.70
	Postremediation[c]	25	4.40	1.60	0.15	0.18	18.50	4.00	27.70	16.50	0.36	0.36	75.70	30.50

Notes: Shading represents where the pre- and post-emediation concentration differed by more than 20 percent.
a All results reported in milligrams per kilogram
b Nondetected results included in average at one-half the detection limit
c Five year average
RASS Remedial action subsite
SD Standard deviation

TABLE 18

COMPARISON OF PREREMEDIATION AND POSTREMEDIAION AVERAGE METALS CONCENTRATIONS IN SURFACE SEDIMENT RESULTS[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Monitoring Period	Number of Results	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
			Average[b]	SD	Average[b]	SD	Average[b]	SD	Average[b]	SD	Average[b]	SD	Average[b]	SD
		Effects-range low	8.20		1.20		34.00		46.70		0.70		150.00	
		Effects-range median	70.00		9.60		270.00		218.00		1.40		410.00	
Spatial Unit 3 Northern Marsh Ditches	Preremediation	2	78.40	2.20	2.80	0.80	126.00	20.60	46.10	4.40	2.10	0.14	1,148.00	219.00
	Postremediation[c]	50	28.20	20.00	1.50	1.70	88.40	45.00	47.50	24.60	2.00	1.30	481.00	470.00
Spatial Unit 7 Central Marsh Ditches	Preremediation	11	190.00	235.00	10.70	10.70	243.00	147.00	63.80	23.50	3.00	1.90	1,529.00	882.00
	Postremediation[c]	89	270.00	428.00	9.30	21.70	345.00	322.00	89.00	75.90	2.80	1.60	1,470.00	1,694.00
Spatial Unit 9 Slough (Northern Reach)	Preremediation	3	15.60	3.10	1.60	1.20	64.30	40.10	41.00	22.00	0.85	0.14	310.00	323.00
	Postremediation[c]	89	29.60	21.10	0.83	1.40	75.80	47.70	29.40	22.50	1.40	0.92	282.00	261.00
Spatial Unit 10 Slough (Central Reach)	Preremediation	7	79.80	51.90	21.10	47.00	136.00	93.80	48.20	27.20	1.20	0.24	2,201.00	4,122.00
	Postremediation[c]	105	82.50	128.00	8.90	17.40	143.00	121.00	50.30	37.20	2.00	1.20	1,587.00	2,019.00
Spatial Unit 13 Nichols Creek and Pond	Preremediation	6	6.80	5.20	7.90	11.20	42.90	37.60	258.00	404.00	1.00	0.38	1,521.00	2,200.00
	Postremediation[c]	162	10.60	24.60	3.10	5.70	40.90	51.60	95.60	328.00	0.61	0.48	1,552.00	2,708.00
Spatial Unit 15 RASS 4 Wetland	Preremediation	4	12.30	14.40	1.90	0.99	48.20	23.20	113.00	49.60	12.10	13.00	335.00	180.00
	Postremediation[c]	24	9.20	3.60	0.68	1.20	46.50	16.80	57.60	83.10	2.50	3.20	212.00	78.10

Notes: Shading represents where the pre- and post-emediation concentration differed by more than 20 percent.
a All results reported in milligrams per kilogram
b Nondetected results included in average at one-half the detection limit
c Five year average
RASS Remedial action subsite
SD Standard deviation

TABLE 19

COMPARISON OF PREREMEDIATION AND POSTREMEDIATION AVERAGE METALS CONCENTRATIONS IN SURFACE WATER[a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Unit	Monitoring Period	Number of Results		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
		Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.
Spatial Unit 3 Northern Marsh Ditches	Preremediation	2	2	81.5	8.8	8.4	1.0	154	3.5	50.2	6.4	15.3	10.0	2535	30.9
	Postremediation	36	0	20.4		1.1		52.2		16.9		1.4		382	
Spatial Unit 7 Central Marsh Ditches	Preremediation	10	10	674	37.2	22.1	1.9	370	4.5	123	7.2	11.3	11.3	3530	1169
	Postremediation	88	6	128	41.4	6.2	0.2	206	34.0	41.8	1.4	1.8	1.3	1254	16.6
Spatial Unit 9 Slough (Northern Reach)	Preremediation	1	2	6.0	1.0	1.0	1.0	21.3	7.0	7.3	4.3	10.0	10.0	63.2	23.7
	Postremediation	71	6	3.9	2.3	0.3	0.2	9.3	14.8	3.5	0.7	1.5	1.2	90.3	36.2
Spatial Unit 10 Slough (Central Reach)	Preremediation	7	7	8.2	4.8	1.7	1.4	11.0	11.1	5.5	3.8	2.4	3.0	215	109
	Postremediation	87	8	11.5	3.6	0.9	0.2	31.0	14.4	11.8	1.0	1.4	1.2	312	71.1
Spatial Unit 13 Nichols Creek and Pond	Preremediation	3	3	6.6	2.0	3.2	1.0	19.6	16.9	17.1	2.7	13.4	5.1	431	112
	Postremediation	116	6	7.5	1.7	3.2	0.2	30.7	13.1	39.8	0.9	3.0	1.7	1526	12.3
Spatial Unit 15 RASS 4 Wetland	Preremediation	4	4	41.9	5.4	5.9	1.0	103	5.1	200	2.2	13.4	6.7	1056	25.1
	Postremediation	20	0	40.8		1.5		103		103		3.4		580	

Notes: Shading indicates that pre- and postremediation average differed by more than 20 percent.

a All surface water results are in micrograms per liter

Diss. Dissolved

TABLE 20

YEAR 5 SUCCESS CRITERIA FOR REVEGETATION MONITORING
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Plant Association	Final Five-year Success Criteria (% Native Cover)	Percent Native Species Cover by Year					Meets Success Criteria?	Reason for Not Meeting Criteria:
		Year 1	Year 2	Year 3	Year 4	Year 5		
RASS 1: Tidal Marsh Revegetation Area (9-acre)								
Pickleweed Marsh	80.0%	22.6%	59.7%	69.5%	75.9%	81.3%	Yes	
Lower Transition Marsh	80.0%	14.3%	9.9%	51.8%	29.8%	83.2%	Yes	
Emergent Marsh	80.0%		58.6%	100.0%	77.1%	100.0%	Yes	
Upland Refugial Mound	80.0%	38.7%	32.9%	23.4%	62.5%	30.0%	No	Nonnative species invasion
RASS 2: Salt Marsh Revegetation Area (4-acre)								
Pickleweed Marsh	80.0%	25.7%	54.6%	41.7%	63.1%	70.3%	No	Nonnative species invasion; Insufficient tidal inundation for these species
Alkaline Upper Marsh	80.0%	19.5%	33.8%	18.1%	52.6%	78.8%	No	
Upper Marsh	80.0%	20.8%	4.1%	14.5%	19.8%	25.1%	No	
RASS 4: Freshwater/Brackish Marsh Area and Annual Grassland (2.5-acre)								
Wetland Revegetation	60.0%	63.3%	79.9%	96.3%	85.1%	99.4%	Yes	

Plantings	Plant Survival Success Criteria (% Survival)	Percentage of Plant Survival by Year					Meets Success Criteria?	Reason for Not Meeting Criteria:
		Year 1	Year 2	Year 3	Year 4	Year 5		
RASS 1-2 Staging Area: Upland Site (1.4-acre)								
Coyote Brush	50.0%		91.0%	90.0%	87.0%	85.0%	Yes	
RASS 4: Freshwater/Brackish Marsh Area and Annual Grassland (2.5-acre)								
Coyote Brush	60.0%	84.0%	71.0%	68.0%	51.7%	55.0%	No	Nonnative species invasion; Reduced topsoil

Notes:

RASS Remedial action subsite

TABLE 21

COMPARISON OF X-RAY FLUORESCENCE AND CONTRACT LABORATORY PROGRAM ANALYTICAL RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Sample ID (Units)	Location ID	Arsenic					Copper					Lead					Zinc				
		XRF (ppm)	CLP (mg/kg)	Note	Difference	RPD (%)	XRF (ppm)	CLP (mg/kg)	Note	Difference	RPD (%)	XRF (ppm)	CLP (mg/kg)	Note	Difference	RPD (%)	XRF (ppm)	CLP (mg/kg)	Note	Difference	RPD (%)
373028-7	R01DH090	105.00	75.50		29.50	32.69	659.00	449.00		210.00	37.91	77.00	50.60		26.40	41.38	7,520.00	4,990.00	J	2,530.00	40.45
373030-7	R01DH099	11.00	5.60		5.40	65.06	27.00	10.30		16.70	89.54	7.00	3.00		4.00	80.00	79.00	40.00	J	39.00	65.55
373027-1	R01DH250	151.00	119.00		32.00	23.70	195.00	134.00		61.00	37.08	55.00	35.90		19.10	42.02	1,100.00	700.00	J	400.00	44.44
373027-2	R01DH250	152.00	112.00		40.00	30.30	243.00	155.00		88.00	44.22	57.00	37.30		19.70	41.78	1,480.00	1,000.00	J	480.00	38.71
373027-3	R01DH250	136.00	105.00		31.00	25.73	203.00	132.00		71.00	42.39	54.00	38.00		16.00	34.78	1,620.00	1,120.00	J	500.00	36.50
373027-4	R01DH250	172.00	138.00		34.00	21.94	201.00	139.00		62.00	36.47	51.00	33.30		17.70	41.99	1,840.00	1,330.00	J	510.00	32.18
373027-5	R01DH250	164.00	129.00		35.00	23.89	262.00	180.00		82.00	37.10	51.00	37.20		13.80	31.29	2,800.00	2,000.00	J	800.00	33.33
373027-6	R01DH250	126.00	98.80		27.20	24.20	280.00	205.00		75.00	30.93	55.00	35.20		19.80	43.90	3,220.00	2,280.00	J	940.00	34.18
373027-7	R01DH250	213.00	172.00		41.00	21.30	727.00	534.00		193.00	30.61	93.00	68.70		24.30	30.06	7,610.00	5,430.00	J	2,180.00	33.44
373019-1	R01DH260	46.00	37.90		8.10	19.31	213.00	169.00		44.00	23.04	156.00	110.00	J	46.00	34.59	917.00	567.00		350.00	47.17
373024-4	R01DH298	260.00	185.00		75.00	33.71	471.00	318.00		153.00	38.78	98.00	71.40	J	26.60	31.40	7,260.00	4,720.00		2,540.00	42.40
373025-7	R01DH299	20.00	27.00		-7.00	29.79	70.00	48.10		21.90	37.09	11.00	12.20		-1.20	10.34	1,030.00	549.00	J	481.00	60.92
373044-7	R01SH098	86.00	69.60		16.40	21.08	230.00	175.00		55.00	27.16	62.00	45.70	J	16.30	30.27	4,330.00	3,190.00		1,140.00	30.32
373043-7	R01SH105	144.00	96.60		47.40	39.40	96.00	72.70		23.30	27.62	52.00	40.00		12.00	26.09	714.00	418.00	J	296.00	52.30
373042-1	R01SH112	57.00	31.30		25.70	58.21	205.00	101.00		104.00	67.97	66.00	35.80		30.20	59.33	1,320.00	631.00	J	689.00	70.63
373041-5	R01SH132	66.00	50.40		15.60	26.80	260.00	162.00		98.00	46.45	69.00	49.90		19.10	32.13	15,200.00	9,900.00	J	5,300.00	42.23
373038-1	R01SH254	65.00	51.40		13.60	23.37	159.00	99.80		59.20	45.75	50.00	35.00		15.00	35.29	3,080.00	1,980.00	J	1,100.00	43.48
373038-2	R01SH254	75.00	56.10		18.90	28.83	196.00	125.00		71.00	44.24	62.00	44.90		17.10	31.99	4,060.00	2,650.00	J	1,410.00	42.03
373038-3	R01SH254	66.00	55.20		10.80	17.82	232.00	167.00		65.00	32.58	69.00	50.50		18.50	30.96	3,930.00	3,040.00	J	890.00	25.54
373038-4	R01SH254	66.00	51.80		14.20	24.11	206.00	160.00		46.00	25.14	67.00	49.60		17.40	29.85	4,450.00	3,310.00	J	1,140.00	29.38
373038-5	R01SH254	97.00	72.30		24.70	29.18	306.00	203.00		103.00	40.47	76.00	61.60		14.40	20.93	8,760.00	5,740.00	J	3,020.00	41.66
373038-6	R01SH254	112.00	88.00		24.00	24.00	321.00	205.00		116.00	44.11	89.00	77.50		11.50	13.81	10,100.00	6,930.00	J	3,170.00	37.23
373038-7	R01SH254	231.00	154.00		77.00	40.00	90.00	54.10		35.90	49.83	17.00	14.60		2.40	15.19	2,990.00	1,650.00	J	1,340.00	57.76
373012-1	R01SS091	310.00	171.00		139.00	57.80	183.00	93.70		89.30	64.55	50.00	29.10	J	20.90	52.84	524.00	266.00		258.00	65.32
373012-2	R01SS091	1,670.00	1,030.00		640.00	47.41	763.00	382.00		381.00	66.55	291.00	171.00	J	120.00	51.95	997.00	462.00		535.00	73.34
373012-3	R01SS091	2,230.00	1,730.00		500.00	25.25	1,280.00	882.00		398.00	36.82	627.00	445.00	J	182.00	33.96	626.00	371.00		255.00	51.15
373012-4	R01SS091	1,930.00	1,270.00		660.00	41.25	1,380.00	842.00		538.00	48.42	685.00	430.00	J	255.00	45.74	554.00	305.00		249.00	57.97
373012-5	R01SS091	2,870.00	2,070.00		800.00	32.39	1,100.00	842.00		258.00	26.57	1,090.00	674.00	J	416.00	47.17	440.00	240.00		200.00	58.82
373012-6	R01SS091	1,550.00	904.00		646.00	52.65	854.00	678.00		176.00	22.98	929.00	505.00	J	424.00	59.14	366.00	166.00		200.00	75.19
373012-7	R01SS091	101.00	64.70		36.30	43.81	107.00	73.10		33.90	37.65	19.00	18.90	J	0.10	0.53	239.00	173.00		66.00	32.04
				Minimum	**-7.00**	**17.82**				**16.70**	**22.98**				**-1.20**	**0.53**				**39.00**	**25.54**
				Maximum	**800.00**	**65.06**				**538.00**	**89.54**				**424.00**	**80.00**				**5,300.00**	**75.19**
				Average	**135.36**	**32.83**				**124.27**	**41.33**				**60.80**	**36.02**				**1,100.27**	**46.52**

Notes:

XRF	X-ray fluorescence
CLP	Contract Laboratory Program
RPD	Relative percent difference
Difference	XRF minus CLP
ppm	Parts per million
mg/kg	Milligrams per kilogram
J	Estimated concentration

TABLE 22

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
Ditches							
R01DH090	373-R01-SD-028	ER-M		70	270	218	410
		1	0.00 - 0.91	103	138	42	833
		2	0.91 - 1.82	78	133	40	740
		3	1.82 - 2.73	87	147	41	843
		4	2.73 - 3.64	108	177	44	1,490
		5	3.64 - 4.55	75	257	48	3,130
		6	4.55 - 5.46	70	343	57	4,670
		10	8.21 - 9.13	105	659	77	7,520
R01DH092	373-R01-SD-031	ER-M		70	270	218	410
		1	0.00 - 1.00	257	219	53	1,670
		2	1.00 - 2.00	239	243	50	1,940
		3	2.00 - 3.00	236	244	56	2,080
		4	3.00 - 4.00	226	289	60	2,540
		5	4.00 - 5.00	257	385	70	2,910
		6	5.00 - 6.00	224	345	74	2,400
		10	9.00 - 10.00	340	382	127	1,880
R01DH099	373-R01-SD-030	ER-M		70	270	218	410
		1	0.00 - 1.00	74	119	40	834
		2	1.00 - 2.00	62	127	40	884
		3	2.00 - 3.00	55	108	36	808
		4	3.00 - 4.00	39	69	22	723
		5	4.00 - 5.00	16	41	11	351
		6	5.00 - 6.00	6	35	9	152
		10	9.00 - 10.00	11	27	7	79
R01DH120	373-R01-SD-034	ER-M		70	270	218	410
		1	0.00 - 0.55	187	603	245	1,230
		2	0.55 - 1.10	243	623	189	785
		3	1.10 - 1.65	237	952	172	764
		4	1.65 - 2.20	235	904	203	1,240
		5	2.20 - 2.75	271	565	148	1,730
		6	2.75 - 3.30	470	678	232	1,470
		10	4.95 - 5.50	417	1,090	152	1,000
R01DH250	373-R01-SD-027	ER-M		70	270	218	410
		1	0.00 - 0.72	151	195	55	1,100
		2	0.72 - 1.44	152	243	57	1,480
		3	1.44 - 2.15	136	203	54	1,620
		4	2.15 - 2.87	172	201	51	1,840
		5	2.87 - 3.59	164	262	51	2,800
		6	3.59 - 4.31	126	280	55	3,220
		10	7.03 - 7.81	213	727	93	7,610
R01DH259	373-R01-SD-029A	ER-M		70	270	218	410
		1	0.00 - 1.00	49	115	39	854
		2	1.00 - 2.00	51	114	33	1,030
		3	2.00 - 3.00	62	132	38	1,290
		4	3.00 - 4.00	61	134	37	1,980
		5	4.00 - 5.00	35	143	41	1,330
		6	5.00 - 6.00	36	151	44	1,550
		10	9.00 - 10.00	7	21	7	32

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01DH260	373-R01-SD-019	ER-M		70	270	218	410
		1	0.00 - 1.00	46	213	156	917
		2	1.00 - 2.00	39	170	82	958
		3	2.00 - 3.00	28	109	39	920
		4	3.00 - 4.00	31	116	39	1,080
		5	4.00 - 5.00	32	115	35	1,140
		6	5.00 - 6.00	29	110	38	1,200
		10	9.00 - 10.00	31	108	30	1,030
R01DH265	373-R01-SD-032	ER-M		70	270	218	410
		1	0.00 - 0.67	381	1,340	76	9,030
		2	0.67 - 1.34	380	1,310	74	9,180
		3	1.34 - 2.01	379	1,410	83	9,500
		4	2.01 - 2.68	384	1,570	85	12,700
		5	2.68 - 3.34	391	1,680	91	14,000
		6	3.34 - 4.01	438	1,920	92	15,300
		10	6.02 - 6.69	530	1,390	153	7,210
R01DH266	373-R01-SD-033	ER-M		70	270	218	410
		1	0.00 - 0.81	737	1,020	209	2,160
		2	0.81 - 1.63	624	701	166	2,460
		3	1.63 - 2.44	394	1,080	139	1,580
		4	2.44 - 3.25	319	874	105	1,830
		5	3.25 - 4.06	333	976	96	1,710
		6	4.06 - 4.88	321	956	65	4,630
		10	8.13 - 8.13	39	128	18	1,080
R01DH288	373-R01-SD-014	ER-M		70	270	218	410
		1	0.00 - 0.86	44	108	32	653
		2	0.86 - 1.73	43	115	34	718
		3	1.73 - 2.59	34	116	36	684
		4	2.59 - 3.45	51	129	35	811
		5	3.45 - 4.31	67	146	42	978
		6	4.31 - 5.18	67	139	40	1,160
		10	7.76 - 8.63	55	258	62	2,680
R01DH289	373-R01-SD-015	ER-M		70	270	218	410
		1	0.00 - 0.90	54	126	38	771
		2	0.90 - 1.80	51	130	33	761
		3	1.80 - 2.70	56	135	37	989
		4	2.70 - 3.60	53	132	40	1,190
		5	3.60 - 4.50	55	149	32	1,250
		6	4.50 - 5.40	54	151	35	1,380
		10	8.10 - 9.00	55	150	46	1,670
R01DH290	373-R01-SD-016	ER-M		70	270	218	410
		1	0.00 - 0.85	123	178	51	1,040
		2	0.85 - 1.70	75	184	43	1,400
		3	1.70 - 2.55	65	180	41	1,320
		4	2.55 - 3.40	73	182	40	1,470
		5	3.40 - 4.25	116	204	45	2,110
		6	4.25 - 5.10	128	325	55	3,100
		10	7.65 - 8.50	56	223	29	5,840

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01DH291	373-R01-SD-017	ER-M		70	270	218	410
		1	0.00 - 0.76	255	241	67	1,300
		2	0.76 - 1.52	192	225	68	1,300
		3	1.52 - 2.28	180	226	58	1,220
		4	2.28 - 3.04	190	222	69	1,320
		5	3.04 - 3.80	205	206	55	1,270
		6	3.80 - 4.56	262	240	62	1,580
		10	6.81 - 7.56	141	233	56	2,610
R01DH292	373-R01-SD-018	ER-M		70	270	218	410
		1	0.00 - 0.91	710	364	124	975
		2	0.91 - 1.82	684	354	127	922
		3	1.82 - 2.73	560	332	105	858
		4	2.73 - 3.64	12	40	8	56
		5	3.64 - 4.55	11	45	6	54
		6	4.55 - 5.46	13	21	3	59
		10	8.21 - 9.13	41	49	10	89
R01DH294	373-R01-SD-020	ER-M		70	270	218	410
		1	0.00 - 0.84	109	159	54	858
		2	0.84 - 1.68	129	184	62	988
		3	1.68 - 2.52	126	192	65	1,050
		4	2.52 - 3.36	124	193	70	1,090
		5	3.36 - 4.20	131	199	68	1,110
		6	4.20 - 5.04	118	226	77	1,210
		10	7.54 - 8.38	112	256	81	1,550
R01DH295	373-R01-SD-021	ER-M		70	270	218	410
		1	0.00 - 0.73	138	175	56	1,040
		2	0.73 - 1.46	149	214	68	1,300
		3	1.46 - 2.19	113	192	69	1,160
		4	2.19 - 2.92	98	188	60	1,130
		5	2.92 - 3.65	90	171	61	1,150
		6	3.65 - 4.38	97	186	47	1,350
		10	6.58 - 7.31	72	177	47	2,130
R01DH296	373-R01-SD-022	ER-M		70	270	218	410
		1	0.00 - 0.93	254	239	75	1,280
		2	0.93 - 1.86	226	249	85	1,390
		3	1.86 - 2.79	188	242	74	1,390
		4	2.79 - 3.72	175	241	75	1,440
		5	3.72 - 4.65	216	249	98	1,180
		6	4.65 - 5.58	295	299	111	1,190
		10	8.38 - 9.31	134	256	42	2,060
R01DH297	373-R01-SD-023	ER-M		70	270	218	410
		1	0.00 - 0.99	51	163	42	876
		2	0.99 - 1.98	56	161	40	895
		3	1.98 - 2.96	63	172	46	1,040
		4	2.96 - 3.95	76	181	44	1,220
		5	3.95 - 4.94	58	166	44	1,060
		6	4.94 - 5.93	72	179	40	1,450
		10	8.89 - 9.88	33	174	40	1,540

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01DH298	373-R01-SD-024	ER-M		70	270	218	410
		1	0.00 - 0.83	137	331	89	3,410
		2	0.83 - 1.65	133	310	93	3,560
		3	1.65 - 2.48	146	339	93	4,380
		4	2.48 - 3.30	260	471	98	7,260
		5	3.30 - 4.13	170	361	89	4,800
		6	4.13 - 4.95	98	225	65	1,910
		10	7.43 - 8.25	37	77	22	746
R01DH299	373-R01-SD-025	ER-M		70	270	218	410
		1	0.00 - 0.55	81	129	33	997
		2	0.55 - 1.10	47	77	19	1,060
		3	1.10 - 1.65	31	67	9	1,000
		4	1.65 - 2.20	17	69	12	783
		5	2.20 - 2.75	11	60	15	704
		6	2.75 - 3.30	11	53	13	679
		10	4.95 - 5.50	20	70	11	1,030
R01DH300	373-R01-SD-026	ER-M		70	270	218	410
		1	0.00 - 0.79	530	657	62	5,680
		2	0.79 - 1.58	665	938	77	5,770
		3	1.58 - 2.36	887	1,210	115	3,730
		4	2.36 - 3.15	670	1,180	127	1,910
		5	3.15 - 3.94	517	1,130	116	1,960
		6	3.94 - 4.73	331	831	90	2,680
		10	7.09 - 7.88	249	340	50	1,970
Slough							
R01SH055	373-R01-SD-035	ER-M		70	270	218	410
		1	0.00 - 1.00	64	103	48	2,940
		2	1.00 - 2.00	65	124	51	3,430
		3	2.00 - 3.00	67	121	49	4,000
		4	3.00 - 4.00	63	103	39	3,620
		5	4.00 - 5.00	76	153	61	7,260
		6	5.00 - 6.00	79	184	68	11,200
		10	9.00 - 10.00	219	132	57	780
R01SH081	373-R01-SD-036	ER-M		70	270	218	410
		1	0.00 - 1.00	43	131	41	2,200
		2	1.00 - 2.00	48	133	45	2,380
		3	2.00 - 3.00	48	141	42	2,320
		4	3.00 - 4.00	49	165	50	2,940
		5	4.00 - 5.00	54	181	61	3,790
		6	5.00 - 6.00	60	179	68	4,540
		10	9.00 - 10.00	55	179	56	4,420
R01SH082	373-R01-SD-037	ER-M		70	270	218	410
		1	0.00 - 1.00	46	131	38	1,940
		2	1.00 - 2.00	48	122	37	1,930
		3	2.00 - 3.00	40	114	32	1,830
		4	3.00 - 4.00	47	137	48	2,460
		5	4.00 - 5.00	53	169	54	3,290
		6	5.00 - 6.00	59	199	62	4,200
		10	9.00 - 10.00	103	360	61	4,670

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01SH098	373-R01-SD-044	ER-M		70	270	218	410
		1	0.00 - 0.74	48	135	40	1,110
		2	0.74 - 1.49	62	150	44	1,540
		3	1.49 - 2.23	70	171	51	2,080
		4	2.23 - 2.98	104	242	60	6,120
		5	2.98 - 3.72	89	255	60	5,500
		6	3.72 - 4.47	112	239	55	11,900
		10	6.69 - 7.44	86	230	62	4,330
R01SH105	373-R01-SD-043	ER-M		70	270	218	410
		1	0.00 - 1.00	66	103	30	526
		2	1.00 - 2.00	38	77	42	256
		3	2.00 - 3.00	36	86	16	280
		4	3.00 - 4.00	59	141	27	730
		5	4.00 - 5.00	44	119	34	822
		6	5.00 - 6.00	56	129	38	1,040
		10	9.00 - 10.00	144	96	52	714
R01SH111	373-R01-SD-039	ER-M		70	270	218	410
		1	0.00 - 1.00	38	113	39	1,130
		2	1.00 - 2.00	43	155	44	1,320
		3	2.00 - 3.00	39	128	42	1,360
		4	3.00 - 4.00	54	157	47	1,710
		5	4.00 - 5.00	41	163	51	1,850
		6	5.00 - 6.00	59	190	51	2,250
		10	9.00 - 10.00	61	157	52	2,220
R01SH112	373-R01-SD-042	ER-M		70	270	218	410
		1	0.00 - 1.00	57	205	66	1,320
		2	1.00 - 2.00	87	143	48	1,260
		3	2.00 - 3.00	52	69	14	501
		4	3.00 - 4.00	44	76	15	412
		5	4.00 - 5.00	23	48	10	258
		6	5.00 - 6.00	18	52	12	101
		10	9.00 - 10.00	15	44	9	111
R01SH130	373-R01-SD-040	ER-M		70	270	218	410
		1	0.00 - 1.00	44	142	43	1,510
		2	1.00 - 2.00	37	141	50	1,460
		3	2.00 - 3.00	43	134	46	1,660
		4	3.00 - 4.00	175	182	63	2,770
		5	4.00 - 5.00	227	203	64	4,690
		6	5.00 - 6.00	271	343	62	6,320
		10	9.00 - 10.00	192	339	65	1,350
R01SH132	373-R01-SD-041	ER-M		70	270	218	410
		1	0.00 - 1.00	43	137	54	2,320
		2	1.00 - 2.00	103	110	44	1,590
		3	2.00 - 3.00	77	98	36	821
		4	3.00 - 4.00	70	108	37	16,400
		5	4.00 - 5.00	66	260	69	15,200
		6	5.00 - 6.00	67	346	127	9,530
		10	9.00 - 10.00	61	72	24	3,420

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01SH254	373-R01-SD-038	ER-M		70	270	218	410
		1	0.00 - 1.00	65	159	50	3,080
		2	1.00 - 2.00	75	196	62	4,060
		3	2.00 - 3.00	66	232	69	3,930
		4	3.00 - 4.00	66	206	67	4,450
		5	4.00 - 5.00	97	306	76	8,760
		6	5.00 - 6.00	112	321	89	10,100
		10	9.00 - 10.00	251	90	17	2,990
Marsh Surface							
MHRSS002	373-R01-MC-001	ER-M		70	270	218	410
		1	0.00 - 1.00	6	20	25	71
		2	1.00 - 2.00	5	19	18	51
		3	2.00 - 3.00	8	17	12	43
		4	3.00 - 4.00	6	12	9	44
		5	4.00 - 5.00	6	18	7	41
		6	5.00 - 6.00	6	19	8	30
		10	9.00 - 10.00	6	20	9	40
R01SS062	373-R01-MC-011	ER-M		70	270	218	410
		1	0.00 - 1.00	19	95	27	269
		2	1.00 - 2.00	42	188	50	464
		3	2.00 - 3.00	89	466	105	691
		4	3.00 - 4.00	488	774	202	1,240
		5	4.00 - 5.00	665	859	249	777
		6	5.00 - 6.00	794	660	220	299
		10	9.00 - 10.00	347	326	84	151
R01SS083	373-R01-MC-010	ER-M		70	270	218	410
		1	0.00 - 1.00	1,000	343	137	774
		2	1.00 - 2.00	983	773	254	966
		3	2.00 - 3.00	1,090	1,160	250	1,040
		4	3.00 - 4.00	1,740	1,280	259	1,260
		5	4.00 - 5.00	3,420	830	445	597
		6	5.00 - 6.00	1,100	904	266	561
		10	9.00 - 10.00	116	239	43	311
R01SS091	373-R01-MC-012	ER-M		70	270	218	410
		1	0.00 - 1.00	310	183	50	524
		2	1.00 - 2.00	1,670	763	291	997
		3	2.00 - 3.00	2,230	1,280	627	626
		4	3.00 - 4.00	1,930	1,380	685	554
		5	4.00 - 5.00	2,870	1,100	1,090	440
		6	5.00 - 6.00	1,550	854	929	366
		10	9.00 - 10.00	101	107	19	239
R01SS095	373-R01-MC-002	ER-M		70	270	218	410
		1	0.00 - 1.00	32	118	96	1,750
		2	1.00 - 2.00	33	129	115	1,540
		3	2.00 - 3.00	50	163	221	2,630
		4	3.00 - 4.00	71	259	179	3,550
		5	4.00 - 5.00	62	225	219	4,010
		6	5.00 - 6.00	86	323	219	4,720
		10	9.00 - 10.00	54	69	52	1,560

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01SS103	373-R01-MC-004	ER-M		70	270	218	410
		1	0.00 - 1.00	19	103	49	1,090
		2	1.00 - 2.00	66	171	123	2,560
		3	2.00 - 3.00	43	331	311	7,200
		4	3.00 - 4.00	52	424	271	8,820
		5	4.00 - 5.00	134	371	116	2,510
		6	5.00 - 6.00	256	275	125	1,970
		10	9.00 - 10.00	322	263	131	2,930
R01SS128	373-R01-MC-013	ER-M		70	270	218	410
		1	0.00 - 1.00	33	371	104	725
		2	1.00 - 2.00	61	339	108	723
		3	2.00 - 3.00	71	839	216	775
		4	3.00 - 4.00	30	448	157	726
		5	4.00 - 5.00	18	300	83	658
		6	5.00 - 6.00	12	290	59	413
		10	9.00 - 10.00	12	62	18	66
R01SS135	373-R01-MC-006	ER-M		70	270	218	410
		1	0.00 - 1.00	90	768	1,860	7,490
		2	1.00 - 2.00	132	1,030	4,250	10,600
		3	2.00 - 3.00	74	1,070	4,940	9,590
		4	3.00 - 4.00	87	1,350	2,760	8,640
		5	4.00 - 5.00	68	1,170	1,030	5,000
		6	5.00 - 6.00	105	530	123	2,830
		10	9.00 - 10.00	171	84	41	2,070
R01SS137	373-R01-MC-007	ER-M		70	270	218	410
		1	0.00 - 1.00	85	730	532	4,270
		2	1.00 - 2.00	224	760	1,020	3,110
		3	2.00 - 3.00	214	740	849	2,870
		4	3.00 - 4.00	120	741	494	2,940
		5	4.00 - 5.00	111	946	654	4,820
		6	5.00 - 6.00	37	246	145	2,110
		10	9.00 - 10.00	8	37	18	752
R01SS242	373-R01-MC-003	ER-M		70	270	218	410
		1	0.00 - 1.00	96	94	78	404
		2	1.00 - 2.00	245	119	179	617
		3	2.00 - 3.00	110	117	145	650
		4	3.00 - 4.00	249	129	162	601
		5	4.00 - 5.00	382	152	207	594
		6	5.00 - 6.00	327	210	179	451
		10	9.00 - 10.00	35	73	19	218
R01SS258	373-R01-MC-005	ER-M		70	270	218	410
		1	0.00 - 1.00	18	182	114	1,060
		2	1.00 - 2.00	39	325	169	1,610
		3	2.00 - 3.00	63	443	223	1,930
		4	3.00 - 4.00	193	536	225	1,370
		5	4.00 - 5.00	404	651	217	493
		6	5.00 - 6.00	481	546	221	251
		10	9.0 - 10.0	125	96	56	264

TABLE 22 (Continued)

ANALYTICAL RESULTS FOR X-RAY FLUORESCENCE SAMPLES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location ID	Sample ID	Section Number	Depth Range (inches)	Arsenic	Copper	Lead	Zinc
R01SS261	373-R01-MC-009	ER-M		70	270	218	410
		1	0.0 - 1.0	82	140	55	1,210
		2	1.0 - 2.0	225	185	88	1,850
		3	2.0 - 3.0	684	202	77	1,400
		4	3.0 - 4.0	140	284	86	956
		5	4.0 - 5.0	244	328	142	920
		6	5.0 - 6.0	508	923	368	1,610
		10	9.0 - 10.0	1,370	810	198	355
R01SS264	373-R01-MC-008	ER-M		70	270	218	410
		1	0.0 - 1.0	433	373	121	757
		2	1.0 - 2.0	283	413	57	899
		3	2.0 - 3.0	757	814	137	1,080
		4	3.0 - 4.0	776	1,310	458	636
		5	4.0 - 5.0	1,120	1,250	595	593
		6	5.0 - 6.0	1,440	1,190	598	492
		10	9.0 - 10.0	1,530	963	362	351

Notes: All concentrations are expressed in ppm (parts per million)
ER-M Effects-range median
ID Identification
XRF X-ray fluorescence

TABLE 23

TIDAL WATER QUALITY SAMPLING RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

1999 TIDAL WATER QUALITY SAMPLING RESULTS

		Incoming Tide					Outgoing Tide					
Date		**1/18/1999**	**2/2/1999**	**2/16/1999**	**3/5/1999**	**3/24/1999**	**1/18/1999**	**2/2/1999**	**2/16/1999**	**3/5/1999**	**3/24/1999**	**3/24/1999**
Sample ID	**AWQC**	**R01SW600**	**R01SW604**	**R01SW608**	**R01SW614**	**R01SW616**	**R01SW602**	**R01SW606**	**R01SW610**	**R01SW612**	**R01SW618**	**R01SW620**
Total Metals (µg/L)												
Arsenic	**36**	**20.3 J**	**1.3 J**	4.2 UJ	4.6 UJ	**2.0 J**	13.0 U	**1.7 J**	**8.3 J**	6.3 UJ	**2.4 J**	**2.5 J**
Cadmium	**6.2**	2.1 U	0.21 U	0.17 U	0.17 U	0.17 U	2.1 U	0.21 U	0.17 U	0.17 U	**1.9 J**	**0.17 U**
Copper	**3.1**	12.2 UJ	8.0 UJ	8.4 UJ	**6.9**	5.5 UJ	15.7 UJ	10.5 UJ	15.8 UJ	**7.9**	7.5 UJ	7.9 UJ
Lead	**8.1**	8.1 U	**1.8 J**	0.95 U	**1.3 J**	0.95 U	8.1 U	**2.3 J**	0.95 U	0.95 U	1.1 UJ	0.95 U
Selenium	**4.6**	22.0 U	2.2 U	2.9 U	2.9 UJ	2.9 U	22.0 U	2.2 U	2.9 U	4.4 UJ	2.9 U	2.9 U
Zinc	**81**	10.0 UJ	**15.2 J**	**25.8**	**29.3**	12.5 UJ	16.7 UJ	**17.8 J**	**35.3**	**20.3**	19.2 UJ	**23.3**

		Incoming Tide					Outgoing Tide					
Sample ID	**AWQC**	**R01SW601**	**R01SW605**	**R01SW609**	**R01SW615**	**R01SW617**	**R01SW603**	**R01SW607**	**R01SW611**	**R01SW613**	**R01SW619**	**R01SW621**
Dissolved Metals (µg/L)												
Arsenic	**36**	**14.3 J**	1.3 U	3.3 UJ	2.7 UJ	**1.7 J**	**16.3**	1.3 U	3.1 UJ	2.0 UJ	**1.8 J**	**1.3 J**
Cadmium	**6.2**	2.1 U	0.45 UJ	0.17 U	0.17 U	0.17 U	2.1 U	0.42 UJ	0.17 U	0.17 U	**5.3**	0.53 UJ
Copper	**3.1**	9.5 UJ	15.5 UJ	7.3 UJ	**10.6**	5.5 UJ	11.3	15.1 UJ	12.2 UJ	**8.4**	5.3 UJ	5.7 UJ
Lead	**8.1**	8.1 U	**1.7 J**	0.95 U	**2.5 J**	0.95 U	8.1 U	**1.9 J**	0.95 U	**1.1 J**	0.95 U	1.7 UJ
Selenium	**4.6**	22.0 U	2.2 U	2.9 U	2.9 UJ	2.9 U	22.0 U	2.2 U	2.9 U	2.9 UJ	2.9 U	2.9 U
Zinc	**81**	5.2 UJ	**15.3 J**	**8.7 J**	**20.4**	7.3 UJ	**6.1**	**16.4 J**	**16.2 J**	**13.8 J**	13.6 UJ	6.7 UJ

2000 TIDAL WATER QUALITY SAMPLING RESULTS

		Incoming Tide						Outgoing Tide				
Date		**10/5/2000**	**10/5/2000**	**10/6/2000**	**10/20/2000**	**10/23/2000**	**10/24/2000**	**10/5/2000**	**10/6/2000**	**10/20/2000**	**10/23/2000**	**10/24/2000**
Sample ID	**AWQC**	**SLR-SW-7U**	**SLR-SW-6U**	**SLR-SW-9U**	**SLR-SW-11U**	**SLR-SW-13U**	**SLR-SW-15U**	**SLR-SW-8U**	**SLR-SW-10U**	**SLR-SW-12U**	**SLR-SW-14U**	**SLR-SW-16U**
Total Metals (µg/L)												
Arsenic	**36**	2.7 UJ	5.1 UJ	3.8 UJ	4.7 UJ	3.9 UJ	2.7 UJ	2.2 U	2.2 U	6.8 UJ	4.7 UJ	4.6 UJ
Cadmium	**6.2**	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.30 UJ	0.20 U	0.20 U
Copper	**3.1**	5.0 UJ	5.4 UJ	4.6 UJ	7.0 UJ	4.3 UJ	**8.7**	2.5 UJ	6.7 UJ	10.8 UJ	7.0 UJ	5.4 UJ
Lead	**8.1**	1.1 UJ	1.1 UJ	1.1 UJ	1.3 U	1.3 U	1.3 U	1.1 UJ	1.1 UJ	1.3 U	1.3 U	1.3 UJ
Selenium	**4.6**	3.3 U	3.3 U	3.3 U	1.5 UJ	3.0 UJ	**8.3 J**	3.3 U	3.3 U	7.5 UJ	1.5 UJ	1.7 UJ
Zinc	**81**	**11.3 J**	**8.5 J**	**11.6 J**	8.6 UJ	10.6 UJ	**25.2**	**14.4 J**	**18.4 J**	19.2 UJ	17.0 UJ	23.6 UJ

		Incoming Tide						Outgoing Tide				
Sample ID	**AWQC**	**SLR-SW-006F**	**SLR-SW-007F**	**SLR-SW-009F**	**SLR-SW-011F**	**SLR-SW-013F**	**SLR-SW-015F**	**SLR-SW-008F**	**SLR-SW-010F**	**SLR-SW-012F**	**SLR-SW-014F**	**SLR-SW-016F**
Dissolved Metals (µg/L)												
Arsenic	**36**	2.2 U	4.5 UJ	2.2 U	3.0 UJ	2.2 U	2.2 U	2.3 UJ	6.3 UJ	2.2 U	7.1 UJ	4.2 UJ
Cadmium	**6.2**	0.20 U	0.30 UJ	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.40 UJ	0.20 U	0.40 UJ	0.20 U
Copper	**3.1**	13.7 UJ	4.6 UJ	1.1 U	**3.0 J**	**13.3**	3.7 UJ	1.1 U	**29.5**	**1.8 J**	**9**	5.1 UJ
Lead	**8.1**	1.1 UJ	1.1 UJ	1.1 UJ	1.3 U	1.3 U	1.3 U	1.1 UJ	1.1 UJ	1.1 U	1.3 U	1.3 UJ
Selenium	**4.6**	3.3 U	3.3 U	3.3 U	1.5 UJ	**2.6 J**	7.5 U	3.3 U	3.3 U	7.5 UJ	1.5 UJ	1.5 UJ
Zinc	**81**	**10.6 J**	7.3 J	9.8 J	14.0 UJ	8.4 UJ	2.6 UJ	4.5 UJ	**6.7 J**	10.5 UJ	11.8 UJ	10.8 UJ

Notes: Detected concentrations are shown in bold type face
Shaded concentrations have detection limits that exceed AWQC.

AWQC Chronic ambient water quality criteria selected for the Litigation Area (see Table 10)
J Estimated value
ID Identification
µg/L Microgram per liter
U Not detected
UJ Not detected; reported detection limit is estimated

TABLE 24

COMPARISON OF NAVY[a] AND RWQCB[b] TIDAL WATER QUALITY SAMPLES
(OCTOBER 2000)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

BRIDGE SAMPLING LOCATIONS (OCTOBER 6, 2000) (all results in µg/L)

Results	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Incoming Tide												
Navy	< 3.8	< 2.2	< 0.20	< 0.20	< 4.6	< 1.1	< 1.1	< 1.1	< 3.3	< 3.3	**11.6 J**	**9.8 J**
RWQCB	NA	NA	**0.067**	**0.043**	**3.67**	**1.67**	**1.14**	< 0.056	NA	NA	NA	NA
Outgoing Tide												
Navy	< 2.2	< 6.3	< 0.20	< 0.40	< 6.7	**29.5**	< 1.1	< 1.1	< 3.3	< 3.3	**18.4 J**	**6.7 J**
RWQCB	NA	NA	**0.075**	**0.057**	**3.11**	**1.77**	**0.784**	<0.056	NA	NA	NA	NA

BRIDGE SAMPLING LOCATIONS (OCTOBER 20, 2000) (all results in µg/L)

Results	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Incoming Tide												
Navy	**4.7**	< 3	< 0.2	< 0.2	< 7	**3.0 J**	< 1.3	< 1.3	< 1.5	< 1.5	**8.6**	< 14
RWQCB	**2.26**	**1.82**	< 0.15	**0.042**	**5.72**	**1.77 J**	**2.050**	< 0.005	**0.133**	**0.111**	**4.9**	< 2.0
Outgoing Tide												
Navy	**6.8**	< 2.2	**0.3**	< 0.2	**10.8**	**1.8 J**	< 1.3	< 1.1	< 7.5	< 7.5	**19.2**	< 10.5
RWQCB	**2.32**	**1.86**	< 0.15	**0.046**	**4.02**	**1.74**	**1.57**	0.006	**0.097**	**0.098**	**4.76**	**2.42**
RWQCB (duplicate)	**2.37**	**1.98**	< 0.15	**0.045**	**4.38**	**1.64**	**1.62**	< 0.005	**0.120**	**0.106**	**5.7**	**2.88**

TABLE 24 (Continued)

COMPARISON OF NAVY[a] AND RWQCB[b] TIDAL WATER QUALITY SAMPLES
(OCTOBER 2000)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

LOCATION R01SH221 (RWQCB results only)

October 20, 2000 Samples	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Incoming tide	NA	NA	< 0.15	0.038	4.43	1.72	1.62	< 0.005	NA	NA	NA	NA
Outgoing tide	NA	NA	< 0.15	0.048	4.92	1.68	1.82	< 0.005	NA	NA	NA	NA

Notes: Detected concentrations are shown in bold typeface.

J Estimated concentration
µg/L Microgram per liter
NA Not available
RWQCB California Regional Water Quality Control Board
a Navy used Contract Laboratory Program analytical procedures.
b RWQCB used ultra-clean sampling methods and low-level analytical methods.

TABLE 25

COMPARISON OF TOTAL AND DISSOLVED COPPER CONCENTRATIONS IN SURFACE WATER SAMPLE PAIRS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Sampling Event	Date	Total Number of Sample Pairs	Dissolved Copper is Greater than 1.1 x Total Copper[a]	Dissolved Copper is Greater than 2 x Total Copper[b]
Nichols Creek sampling	3/25/98 to 3/31/98	11	2	0
Year 4 postremediation monitoring	6/19/98 to 6/24/98	10	0	0
Storm event sampling	2/16/99 to 4/8/99	36	4	0
Year 5 postremediation Monitoring	5/10/99 to 6/8/99	18	9	8
Slough mouth tidal water sampling in 1999	1/18/99 to 4/8/99	13	2	0
Slough mouth tidal water sampling in 2000	10/5/00 to 10/24/00	12	3	2
Bioassay surface water sampling	10/9/00 to 10/23/00	20	3	3
	Total	**120**	**23**	**13**

Notes:

a Number of sample pairs where filtered (dissolved) copper concentrations exceed unfiltered (total) concentration by more than 10 percent

b Number of sample pairs where filtered (dissolved) copper concentration exceeds unfiltered (total) concentration by more than 100 percent

TABLE 26

TOTAL DISSOLVED SOLIDS, RECHARGE CHARACTERISTICS, AND LITHOLOGY OF LITIGATION AREA WELLS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Well ID	TDS Greater than 10,000 mg/L[a]	Recharge rate Less than 0.1 L/min[b]	No Sand or Gravel[c]	Potentially Potable
1MG01		*	X	
1AG02	X		X	
1AG03	X	*	X	
1AG04	X	X	X	
1PG05	X		X	
1PG18	X		X	
2MG07	X	X	X	
2AG08	X	*	X	
2AG09		X	X	
2MG20		*		X
2MG21		*		X
2MG22		*		X
3MG06		*	X	
3AG10			X	
3MG11			X	
3MG12			X	
3MG13		*		X
3MG14		*		X
3MG19		*		X
4MG15		X		
4MG16		X		
4MG17		*		X

Notes:

L/min	liters per minute
mg/L	milligrams per liter
TDS	Total Dissolved Solids
TDS	Total Dissolved Solids
a	1989 IT quarterly sampling data showed TDS consistently exceeds 10,000 mg/L.
b	Well was unable to sustain 0.1 L/min purge rate during 1997 sampling.
c	Lithologic logs show no sand or gravel lenses in well.
*	Well not sampled in 1997.

TABLE 27

REMEDIAL ACTION SUBSITE 1 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Metals									
Aluminum	64	64	49,500	9,190	25,753.44	0	0	76,000	27,000
Antimony	59	30	4.6	0.75	2.21	0	0	31	1.9
Arsenic	186	186	3,260	10.4	212.23	186	140	0.39	26
Barium	64	64	367	41.3	104.13	0	0	5,400	420
Beryllium	64	29	1	0.21	0.57	0	0	150	0.13
Cadmium	184	157	832	0.25	18.3	43	43	9	0.55
Chromium	64	64	121	15.6	71.31	0	0	210	81
Cobalt	64	64	48.1	4.3	17.23	0	0	4,700	24
Copper	186	186	1,560	25.8	256.1	0	0	2,900	73
Iron	64	64	60,500	8,620	37,475.31	56	1	23,000	58,000
Lead	186	186	872	6.5	110	5	5	400	70
Manganese	64	64	9,620	103	575.81	1	1	1,800	1,200
Mercury	64	50	0.87	0.06	0.4	0	0	23	0.25
Molybdenum	64	50	8.1	0.45	3.55	0	0	390	6.2
Nickel	64	64	136	21.5	75.58	0	0	150	110
Selenium	186	151	9.6	0.46	3.64	0	0	390	NA
Silver	64	6	3.1	0.45	1.29	0	0	390	NA
Thallium	64	3	5.4	1.5	3.2	1	1	5.2	1.8
Vanadium	64	64	130	32.8	90.62	0	0	550	91
Zinc	186	186	89,300	49.8	2,329.27	2	2	23,000	210

TABLE 27 (Continued)

REMEDIAL ACTION SUBSITE 1 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Semivolatile Organic Compounds									
1,2,4-Trichlorobenzene	67	1	0.2	0.2	0.2	0	0	650	NA
2-Methylnaphthalene	67	1	0.085	0.085	0.085	0	0	22,000	NA
4-Methylphenol	67	1	0.084	0.084	0.084	0	0	310	NA
Acenaphthene	67	1	0.084	0.084	0.084	0	0	3,700	NA
Benzo(a)anthracene	67	3	0.17	0.064	0.11	0	0	0.62	NA
Benzo(a)pyrene	67	5	0.14	0.047	0.083	3	3	0.062	NA
Benzo(b)fluoranthene	67	3	0.17	0.052	0.11	0	0	0.62	NA
Benzo(g,h,i)perylene	67	4	1	0.059	0.58	0	0	2,300	NA
Benzo(k)fluoranthene	67	1	0.053	0.053	0.053	0	0	0.61	NA
Butylbenzylphthalate	67	1	0.49	0.49	0.49	0	0	12,000	NA
Chrysene	67	4	0.19	0.064	0.12	0	0	62	NA
Fluoranthene	67	8	0.38	0.055	0.18	0	0	2,300	NA
Indeno(1,2,3-cd)pyrene	67	1	0.046	0.046	0.046	0	0	0.62	NA
Phenanthrene	67	1	0.17	0.17	0.17	0	0	22,000	NA
Pyrene	67	14	0.41	0.017	0.11	0	0	2,300	NA
Pesticides/Polychlorinated Biphenyls									
4,4'-DDD	70	6	0.018	0.0056	0.011	0	0	2.4	NA
4,4'-DDE	70	9	0.011	0.0037	0.0063	0	0	1.7	NA
4,4'-DDT	70	2	0.019	0.0065	0.013	0	0	1.7	NA
alpha-BHC	70	1	0.0067	0.0067	0.0067	0	0	0.09	NA
alpha-Chlordane	70	2	0.0043	0.0041	0.0042	0	0	1.6	NA
Aroclor-1260	70	1	0.21	0.21	0.21	0	0	0.22	NA
beta-BHC	70	2	0.023	0.0015	0.012	0	0	0.32	NA

TABLE 27 (Continued)

REMEDIAL ACTION SUBSITE 1 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Pesticides/Polychlorinated Biphenyls (Continued)									
Dieldrin	70	1	0.022	0.022	0.022	0	0	0.03	NA
Endosulfan II	70	2	0.02	0.012	0.016	0	0	370	NA
Endosulfan sulfate	70	1	0.0044	0.0044	0.0044	0	0	370	NA
Endrin	70	1	0.0076	0.0076	0.0076	0	0	18	NA
Endrin aldehyde	70	2	0.0096	0.0029	0.0063	0	0	18	NA
Endrin ketone	70	1	0.027	0.027	0.027	0	0	18	NA
gamma-BHC (lindane)	70	2	0.014	0.0041	0.0091	0	0	0.44	NA
Heptachlor	70	4	0.0098	0.0025	0.0052	0	0	0.11	NA
Pentachlorophenol	67	1	0.61	0.61	0.61	0	0	3	NA

Notes:

BHC Hexachlorocyclohexane (formerly benzene hexachloride)
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligram per kilogram
NA An ambient limit has not been established for this analyte.
PRG Preliminary remediation goal

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.
b Includes all analytes detected at one or more sampling locations.
c For inorganic chemicals, results less than 10 mg/kg are reported to two significant figures, and results greater than 10 mg/kg are reported to three significant figures. For organic chemicals, results less than 10 mg/kg are reported to one significant figure, and results greater than 10 mg/kg are reported to two significant figures. "R" (rejected) data were excluded from the data set.
d If an ambient limit is not available, the number of discrete locations with sample concentrations greater than the PRG is shown; conversely, if a PRG is not available, the number of discrete locations with sample concentrations greater than the ambient limit is shown.
e U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000).
f The ambient limit is the 95th percentile of the ambient data set for the Tidal Area (see Section 3.1.2 of Appendix F).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 28

REMEDIAL ACTION SUBSITE 2 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Metals									
Aluminum	1	1	19700	19700	19700	0	0	76000	27000
Antimony	1	1	0.72	0.72	0.72	0	0	31	1.9
Arsenic	21	21	528	13.6	90	21	12	0.39	26
Barium	1	1	132	132	132	0	0	5400	420
Beryllium	1	1	0.55	0.55	0.55	0	0	150	0.13
Cadmium	21	21	38.6	0.93	7.2	7	7	9	0.55
Chromium	1	1	31.9	31.9	32	0	0	210	81
Cobalt	1	1	10.8	10.8	11	0	0	4700	24
Copper	21	21	894	53.8	290	0	0	2900	73
Iron	1	1	21400	21400	21400	0	0	23000	58000
Lead	21	21	6060	38.8	542	7	7	400	70
Manganese	1	1	549	549	549	0	0	1800	1200
Mercury	1	1	0.05	0.05	0.05	0	0	23	0.25
Molybdenum	1	1	0.58	0.58	0.58	0	0	390	6.2
Nickel	1	1	24.3	24.3	24	0	0	150	110
Selenium	21	20	5.8	0.26	1.4	0	0	390	NA
Thallium	1	1	0.26	0.26	0.26	0	0	5.2	1.8
Vanadium	1	1	52.9	52.9	53	0	0	550	91
Zinc	21	21	10800	206	2164	0	0	23000	210
Pesticides/Polychlorinated Biphenyls									
4,4'-DDT	1	1	0.0019	0.0019	0.0019	0	0	1.7	NA

TABLE 28 (Continued)

REMEDIAL ACTION SUBSITE 2 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

DDT	Dichlorodiphenyltrichloroethane
mg/kg	Milligram per kilogram
NA	An ambient limit has not been established for this analyte.
PRG	Preliminary remediation goal

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.

b Includes all analytes detected at one or more sampling locations.

c For inorganic chemicals, results less than 10 mg/kg are reported to two significant figures, and results greater than 10 mg/kg are reported to three significant figures. For organic chemicals, results less than 10 mg/kg are reported to one significant figure, and results greater than 10 mg/kg are reported to two significant figures. "R" (rejected) data were excluded from the data set.

d If an ambient limit is not available, the number of discrete locations with sample concentrations greater than the PRG is shown; conversely, if a PRG is not available, the number of discrete locations with sample concentrations greater than the ambient limit is shown.

e U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000).

f The ambient limit is the 95th percentile of the ambient data set for the Tidal Area (see Section 3.1.2 of Appendix F).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 29

REMEDIAL ACTION SUBSITE 3 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Metals									
Aluminum	17	17	50700	7430	21300	0	0	76000	20000
Antimony	16	11	1.5	0.39	0.92	0	0	31	1.2
Arsenic	65	65	190	3	16	65	33	0.39	7.3
Barium	17	17	745	107	235	0	0	5400	210
Beryllium	17	17	1.6	0.35	0.59	0	0	150	0.56
Cadmium	62	51	55.7	0.16	6.3	10	10	9	0.15
Chromium	17	17	95.4	19.6	43	0	0	210	55
Cobalt	17	17	20	9.3	13	0	0	4700	24
Copper	65	65	327	7.5	60	0	0	2900	64
Iron	17	17	76600	12100	28982	9	9	23000	NA
Lead	65	65	2990	6.7	196	5	5	400	18
Manganese	17	17	752	377	550	0	0	1800	870
Mercury	17	12	0.55	0.03	0.1	0	0	23	0.14
Molybdenum	17	17	2.7	0.34	0.98	0	0	390	NA
Nickel	17	17	83.9	15.4	40	0	0	150	86
Selenium	65	37	3.2	0.44	1.2	0	0	390	NA
Silver	17	1	0.81	0.81	0.81	0	0	390	NA
Toluene	7	2	0.004	0.004	0.004	0	0	520	NA
Vanadium	17	17	125	38.7	65	0	0	550	86
Zinc	65	65	23100	40.5	2697	1	1	23000	83
Volatile Organic Compounds									
Carbon disulfide	7	1	0.008	0.008	0.008	0	0	360	NA

TABLE 29 (Continued)

REMEDIAL ACTION SUBSITE 3 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Semivolatile Organic Compounds									
Benzo(a)anthracene	17	1	0.14	0.14	0.14	0	0	0.62	NA
Benzo(a)pyrene	17	1	0.41	0.41	0.41	1	1	0.062	NA
Benzo(b)fluoranthene	17	1	0.37	0.37	0.37	0	0	0.62	NA
Benzo(g,h,i)perylene	17	1	0.075	0.075	0.075	0	0	2300	NA
Carbazole	17	1	0.033	0.033	0.033	0	0	24	NA
Chrysene	17	1	0.25	0.25	0.25	0	0	62	NA
Fluoranthene	17	1	0.26	0.26	0.26	0	0	2300	NA
Indeno(1,2,3-cd)pyrene	17	1	0.1	0.1	0.1	0	0	0.62	NA
Phenanthrene	17	1	0.12	0.12	0.12	0	0	22000	NA
Pyrene	17	1	0.31	0.31	0.31	0	0	2300	NA
Pesticides/Polychlorinated Biphenyls									
4,4'-DDD	20	4	0.011	0.0022	0.0062	0	0	2.4	NA
4,4'-DDE	20	1	0.0032	0.0032	0.0032	0	0	1.7	NA
4,4'-DDT	20	5	0.035	0.0032	0.014	0	0	1.7	NA
Aldrin	20	2	0.035	0.021	0.028	1	1	0.029	NA
alpha-Chlordane	20	3	0.0019	0.0015	0.0017	0	0	1.6	NA
Aroclor-1242	20	1	1.5	1.5	1.5	1	1	0.22	NA
Aroclor-1248	20	3	0.62	0.07	0.39	2	2	0.22	NA
beta-BHC	20	1	0.0032	0.0032	0.0032	0	0	0.32	NA
Dieldrin	20	2	0.0034	0.0021	0.0028	0	0	0.03	NA
Endosulfan I	20	1	0.0097	0.0097	0.0097	0	0	370	NA

TABLE 29 (Continued)

REMEDIAL ACTION SUBSITE 3 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Pesticides/Polychlorinated Biphenyls (Continued)									
Endosulfan II	20	1	0.022	0.022	0.022	0	0	370	NA
Endosulfan sulfate	20	4	0.018	0.0022	0.011	0	0	370	NA
Endrin	20	2	0.0047	0.00011	0.0024	0	0	18	NA
Endrin aldehyde	20	9	0.017	0.0026	0.010	0	0	18	NA
Endrin ketone	20	2	0.0061	0.0055	0.0058	0	0	18	NA
gamma-Chlordane	20	2	0.006	0.005	0.0055	0	0	1.6	NA
Heptachlor	20	1	0.0031	0.0031	0.0031	0	0	0.11	NA
Heptachlor epoxide	20	1	0.0028	0.0028	0.0028	0	0	0.053	NA
Methoxychlor	20	3	0.04	0.013	0.023	0	0	310	NA

Notes:

BHC Hexachlorocyclohexane (formerly benzene hexachloride)
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligram per kilogram
NA An ambient limit has not been established for this analyte.
PRG Preliminary remediation goal

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.
b Includes all analytes detected at one or more sampling locations.
c For inorganic chemicals, results less than 10 mg/kg are reported to two significant figures, and results greater than 10 mg/kg are reported to three significant figures. For organic chemicals, results less than 10 mg/kg are reported to one significant figure, and results greater than 10 mg/kg are reported to two significant figures. "R" (rejected) data were excluded from the data set.
d If an ambient limit is not available, the number of discrete locations with sample concentrations greater than the PRG is shown; conversely, if a PRG is not available, the number of discrete locations with sample concentrations greater than the ambient limit is shown.
e U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000, as listed in Appendix F).
f The ambient limit is the 95th percentile of the ambient data set for the Tidal Area (see Section 3.1.2 of Appendix F).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 30

REMEDIAL ACTION SUBSITE 4 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Metals									
Aluminum	7	7	21400	12800	17943	0	0	76000	20000
Antimony	6	6	1.9	0.71	1.3	0	0	31	1.2
Arsenic	18	18	206	9.3	59	18	18	0.39	7.3
Barium	7	7	311	118	222	0	0	5400	210
Beryllium	7	2	0.48	0.36	0.42	0	0	150	0.56
Cadmium	18	18	22.1	0.46	6.8	5	5	9	0.15
Chromium	7	7	86	28.2	45	0	0	210	55
Cobalt	7	7	15.6	3.4	10	0	0	4700	24
Copper	18	18	164	41.5	80	0	0	2900	64
Iron	7	7	28800	11900	20129	3	3	23000	NA
Lead	18	18	5980	29.1	633	5	5	400	18
Manganese	7	7	553	103	313	0	0	1800	870
Mercury	18	18	143	0.06	15	3	3	23	0.14
Molybdenum	7	4	1.7	1.3	1.5	0	0	390	NA
Nickel	7	7	43.3	13.3	29	0	0	150	86
Selenium	18	18	657	1.1	76	2	2	390	NA
Silver	7	2	0.66	0.31	0.49	0	0	390	NA
Vanadium	7	7	79.7	44.1	65	0	0	550	86
Zinc	18	18	572	112	244	0	0	23000	83
Semivolatile Organic Compounds									
Chrysene	4	1	0.017	0.017	0.017	0	0	62	NA
Fluoranthene	4	1	0.023	0.023	0.023	0	0	2300	NA
Pyrene	4	1	0.022	0.022	0.022	0	0	2300	NA

TABLE 30 (Continued)

REMEDIAL ACTION SUBSITE 4 STATISTICAL SUMMARY OF SOIL AND SEDIMENT ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (mg/kg)	Minimum Detected Concentration [c] (mg/kg)	Average Detected Concentration (mg/kg)	Number of Locations with Concentrations Exceeding the PRG	Number of Locations with Concentrations Exceeding the PRG and Ambient Limit [d]	Residential PRG [e] (mg/kg)	Ambient Limit [f] (mg/kg)
Pesticides/Polychlorinated Biphenyls									
4,4'-DDD	7	5	0.28	0.004	0.061	0	0	2.4	NA
4,4'-DDE	7	4	0.026	0.003	0.0092	0	0	1.7	NA
4,4'-DDT	7	4	0.029	0.00062	0.014	0	0	1.7	NA
alpha-Chlordane	7	5	0.035	0.0011	0.016	0	0	1.6	NA
Aroclor-1242	7	1	0.045	0.045	0.045	0	0	0.22	NA
Dieldrin	7	2	0.0055	0.0013	0.0034	0	0	0.03	NA
Endosulfan sulfate	7	1	0.02	0.02	0.02	0	0	370	NA
Endrin aldehyde	7	1	0.0035	0.0035	0.0035	0	0	18	NA
gamma-Chlordane	7	5	0.026	0.0039	0.013	0	0	1.6	NA
Heptachlor	7	1	0.0017	0.0017	0.0017	0	0	0.11	NA

Notes:

DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane

mg/kg Milligram per kilogram
NA An ambient limit has not been established for this analyte.
PRG Preliminary remediation goal

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.

b Includes all analytes detected at one or more sampling locations.

c For inorganic chemicals, results less than 10 mg/kg are reported to two significant figures, and results greater than 10 mg/kg are reported to three significant figures. For organic chemicals, results less than 10 mg/kg are reported to one significant figure, and results greater than 10 mg/kg are reported to two significant figures. "R" (rejected) data were excluded from the data set.

d If an ambient limit is not available, the number of discrete locations with sample concentrations greater than the PRG is shown; conversely, if a PRG is not available, the number of discrete locations with sample concentrations greater than the ambient limit is shown.

e U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000).

f The ambient limit is the 95th percentile of the ambient data set for the Tidal Area (see Section 3.1.2 of Appendix F).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 31

REMEDIAL ACTION SUBSITE 1 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Metals							
Aluminum	139	36	64800	22	7822	4	36000
Antimony	140	11	1800	1.7	620	6	15
Arsenic	515	96	2970	3	139	96	0.045
Barium	140	37	528	19.6	108	0	2600
Beryllium	140	2	1.2	1.1	1.2	0	73
Cadmium	515	48	207	0.3	20	11	18
Chromium	140	29	1100	2.7	90	0	55000
Cobalt	140	29	70	0.57	9.1	0	2200
Copper	515	86	7240	5.1	285	4	1400
Iron	140	39	122000	62.8	14595	8	11000
Lead	511	87	1330	1.4	70.5	--	--
Manganese	140	39	4800	31.2	698	7	880
Mercury	134	16	1.7	0.11	0.45	0	11
Molybdenum	116	16	5	0.45	2.0	0	180
Nickel	140	27	683	4.5	72	0	730
Selenium	508	11	14.1	1.6	6.7	0	180
Silver	140	15	82	1	19	0	180
Thallium	140	1	87.6	87.6	88	1	2.4
Vanadium	140	37	290	0.85	31	1	260
Zinc	515	103	40100	17.1	2200	5	11000

TABLE 31 (Continued)

REMEDIAL ACTION SUBSITE 1 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Volatile Organic Compounds							
1,1,1-Trichloroethane	16	1	19	19	19	0	540
1,1-Dichloroethane	16	1	6	6	6	1	2
Acetone	16	3	19	12	15	0	610
Methylene chloride	16	1	18	18	18	1	4.3
Semivolatile Organic Compounds							
Bis(2-ethylhexyl)phthalate	43	1	33	33	33	1	4.8
Phenol	43	1	160	160	160	0	22000
Pesticides / Polychlorinated Biphenyls							
4,4'-DDT	31	1	0.027	0.027	0.027	0	0.2
Aldrin	31	1	0.02	0.02	0.02	1	0.004
Dieldrin	31	1	0.041	0.041	0.041	1	0.0042
Endrin	31	1	0.041	0.041	0.041	0	11
gamma-BHC (Lindane)	31	1	0.018	0.018	0.018	0	0.052
Heptachlor	31	1	0.022	0.022	0.022	1	0.015

TABLE 31 (Continued)

REMEDIAL ACTION SUBSITE 1 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

BHC	Hexachlorocyclohexane (formerly benzene hexachloride)
DDT	Dichlorodiphenyltrichloroethane
µg/L	Microgram per liter
PRG	Preliminary remediation goal
--	Not available

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.

b Includes all analytes detected at one or more sampling locations.

c For inorganic chemicals, results less than 10 µg/L are reported to two significant figures, and results greater than 10 µg/L are reported to three significant figures. For organic chemicals, results less than 10 µg/L are reported to one significant figure, and results greater than 10 µg/L are reported to two significant figures. "R" (rejected) data were excluded from the data set.

d U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 32

REMEDIAL ACTION SUBSITE 2 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Metals							
Aluminum	25	6	14000	2700	6250	0	36000
Antimony	25	5	2500	60	804	5	15
Arsenic	31	6	51	4.8	20	6	0.045
Barium	25	2	43.5	21.8	33	0	2600
Beryllium	25	1	1.1	1.1	1.1	0	73
Cadmium	31	5	60	11.4	26	2	18
Chromium	25	5	2800	60	645	0	55000
Cobalt	25	2	18.5	9.1	13.8	0	2200
Copper	31	5	160	6.9	87.9	0	1400
Iron	25	6	18000	3200	8167	1	11000
Lead	31	5	1000	30	358	--	--
Manganese	25	6	10000	30	6272	5	880
Mercury	25	2	0.3	0.12	0.21	0	11
Molybdenum	2	2	36.5	11	24	0	180
Nickel	25	5	1390	17	325	1	730
Selenium	31	3	66	15	32	0	180
Silver	25	1	32	32	32	0	180
Vanadium	25	2	33.6	6.5	20	0	260
Zinc	31	6	22000	200	3903	1	11000

TABLE 32 (Continued)

REMEDIAL ACTION SUBSITE 2 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Volatile Organic Compounds							
Acetone	14	1	14	14	14	0	610
Methylene Chloride	14	2	41	6	24	2	4.3
Semivolatile Organic Compounds							
Bis(2-ethylhexyl)phthalate	14	2	21	12	17	2	4.8

Notes:

µg/L Microgram per liter
PRG Preliminary remediation goal
-- Not available

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.
b Includes all analytes detected at one or more sampling locations.
c For inorganic chemicals, results less than 10 µg/L are reported to two significant figures, and results greater than 10 µg/L are reported to three significant figures. For organic chemicals, results less than 10 µg/L are reported to one significant figure, and results greater than 10 µg/L are reported to two significant figures. "R" (rejected) data were excluded from the data set.
d U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000, as listed in Appendix F).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 33

REMEDIAL ACTION SUBSITE 3 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Metals							
Aluminum	55	15	3700	400	1322	0	36000
Antimony	55	3	90	2.5	39	2	15
Arsenic	163	41	73	2	12	41	0.045
Barium	55	13	507	16	235	0	2600
Beryllium	55	1	1.6	1.6	1.6	0	73
Cadmium	163	28	249	0.3	15	3	18
Chromium	55	7	520	20	156	0	55000
Copper	163	32	640	1.9	66	0	1400
Iron	55	16	4800	824	2142	0	11000
Lead	162	38	1110	0.84	96.1	--	--
Manganese	55	16	990	30	173	1	880
Mercury	55	3	0.4	0.1	0.23	0	11
Molybdenum	27	3	44	0.91	15	0	180
Nickel	55	10	220	4	42	0	730
Selenium	163	15	17	2.1	7.2	0	180
Silver	55	3	18	3.7	9.7	0	180
Vanadium	55	12	25	4.8	13	0	260
Zinc	163	47	105000	19	4021	4	11000

TABLE 33 (Continued)

REMEDIAL ACTION SUBSITE 3 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Volatile Organic Compounds							
Acetone	17	3	15	13	14	0	610
Semivolatile Organic Compounds							
Bis(2-ethylhexyl)phthalate	21	5	26	11	17	5	4.8

Notes:

µg/L Microgram per liter
PRG Preliminary remediation goal
-- Not available

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.
b Includes all analytes detected at one or more sampling locations.
c For inorganic chemicals, results less than 10 µg/L are reported to two significant figures, and results greater than 10 µg/L are reported to three significant figures. For organic chemicals, results less than 10 µg/L are reported to one significant figure, and results greater than 10 µg/L are reported to two significant figures. "R" (rejected) data were excluded from the data set.
d U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 34

REMEDIAL ACTION SUBSITE 4 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte [b]	Number of Locations Analyzed	Number of Locations with a Detected Concentration	Maximum Detected Concentration [c] (µg/L)	Minimum Detected Concentration [c] (µg/L)	Average Detected Concentration (µg/L)	Number of Locations with Concentrations Exceeding PRG	Residential PRG [d] (µg/L)
Metals							
Aluminum	16	5	41900	581	11496	1	36000
Antimony	16	3	190	3.7	91	2	15
Arsenic	36	9	261	2.8	78	9	0.045
Barium	16	4	800	37	239	0	2600
Beryllium	16	2	3.4	1.4	2.4	0	73
Cadmium	36	3	12	0.57	7	0	18
Chromium	16	4	1060	57	449	0	55000
Cobalt	16	3	36	1.5	14	0	2200
Copper	36	8	1130	4	211	0	1400
Iron	16	5	57500	493	17119	2	11000
Lead	15	3	103	33.7	59.8	--	--
Manganese	16	5	5960	480	1809	2	880
Mercury	35	7	1.8	0.11	0.59	0	11
Molybdenum	4	2	26	2.5	14	0	180
Nickel	16	5	2900	9.7	1273	3	730
Selenium	36	4	21	6.5	14	0	180
Silver	16	1	46	46	46	0	180
Vanadium	16	4	170	6.8	49	0	260
Zinc	36	8	5500	38	1260	0	11000
Semivolatile Organic Compounds							
Bromoform	8	1	7	7	7	0	8.5

TABLE 34 (Continued)

REMEDIAL ACTION SUBSITE 4 STATISTICAL SUMMARY OF SURFACE WATER ANALYSES
HUMAN HEALTH RISK ASSESSMENT DATA SET [a]
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

µg/L	Microgram per liter
PRG	Preliminary remediation goal
--	Not available

a The human health risk assessment data set was based on the analytical results from the qualitative ecological risk assessment and five-year monitoring program. For sampling locations where more than one sample was collected, the maximum detected concentration was used to represent that location. A detailed discussion of the data is provided in Section 3.1.1 of Appendix F.

b Includes all analytes detected at one or more sampling locations.

c For inorganic chemicals, results less than 10 µg/L are reported to two significant figures, and results greater than 10 µg/L are reported to three significant figures. For organic chemicals, results less than 10 µg/L are reported to one significant figure, and results greater than 10 µg/L are reported to two significant figures. "R" (rejected) data were excluded from the data set.

d U.S. Environmental Protection Agency (EPA) Region 9 PRG for residential land use (EPA 2000).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 35

AMBIENT METAL CONCENTRATIONS
IN TIDAL AREA AND INLAND AREA SOILS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Tidal Area[a] Ambient Concentration (mg/kg)	Inland Area Sites 17 and 24[b] Ambient Concentration (mg/kg)
Aluminum	27,000	20,000
Antimony	1.9	1.2
Arsenic	26	7.3
Barium	420	210
Beryllium	0.13	0.56
Cadmium	0.55	0.15
Chromium	81	55
Cobalt	24	24
Copper	73	64
Iron	58,000	--
Lead	70	18
Manganese	1,200	870
Mercury	0.25	0.14
Molybdenum	6.2	--
Nickel	110	86
Thallium	1.8	--
Vanadium	91	86
Zinc	210	83

Notes:

mg/kg Milligram per kilogram

-- Not available

a Ambient concentration used for RASS 1 and 2. Value shown is the 95th percentile of the ambient data set (Tetra Tech Environmental Management Inc. [TtEMI] 1999b, as listed in Appendix F).

b Ambient concentration used for RASS 3 and 4. Value shown is the 95th percentile of the ambient data set (TtEMI and Montgomery Watson 1997, as listed in Appendix F).

TABLE 36

EXPOSURE PARAMETERS FOR THE COMMERCIAL/INDUSTRIAL WORKER, RESIDENT, AND MOSQUITO ABATEMENT WORKER RECEPTORS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Symbol	Resident Adult[a]	Resident Child[a]	Commercial/ Industrial Worker[a]	Mosquito Abatement Worker[b]	Unit
General Parameters						
Body Weight	BW	70	15	70	70	kg
Exposure Frequency	EF	350	350	250	30	days/year
Exposure Duration	ED	24	6	25	25	years
Averaging Time for Carcinogens	ATc	25,550	25,550	25,550	25,550	days
Averaging Time for Noncarcinogens	ATnc	8,760	2,190	9,125	9,125	days
Soil Ingestion						
Soil Ingestion Rate	IRS	100	200	50	100	mg/day
Conversion Factor	CF	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	unitless
Dermal Contact with Soil						
Exposed Surface Area for Soil/Dust	SA	5,700	2,800	3,300	3,300	cm^2/day
Soil to Skin Adherence Factor	AF	0.07	0.2	0.2	0.8	mg/cm^2
Skin Absorption	ABS	chemical-specific	chemical-specific	chemical-specific	hemical-specifi	unitless
Inhalation of Particulates						
Inhalation Rate	IRA	20	10	20	15	m^3/day
Particulate Emission Factor	PEF	1.32×10^9	1.32×10^9	1.32×10^9	1.32×10^9	m^3/kg
Surface Water Ingestion						
Drinking Water Ingestion	IRW	2	1	2	--	L/day
Dermal Contact with Surface Water						
Skin Surface Area	SAsw	--	--	--	2100	cm^2
Event Frequency	EV	--	--	--	1	events/day
Water Contact Time	Tevent	--	--	--	1	hr
Stratum Corneum Thickness	--	--	--	--	0.001	cm

Notes:

kg	Kilogram	cm^2	Square centimeter
mg	Milligram	m^3	Cubic meter
hr	Hour	PRG	Preliminary remediation goal

a Default exposure parameters used by EPA Region 9 to derive the PRGs.

b The exposure parameter values for the mosquito abatement worker are discussed in Section 4.3 of Appendix F.

TABLE 37

TIER 1 PRELIMINARY REMEDIATION GOALS FOR SOIL AND SEDIMENT
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Soil Cancer PRGs (mg/kg)				Soil Noncancer PRGs (mg/kg)			
	Residential	Notes	Industrial	Notes	Residential	Notes	Industrial	Notes
Metals								
Aluminum	--		--		76000		100000	max
Antimony	--		--		31		820	
Arsenic	0.39		2.7		22		440	
Barium	--		--		5400		100000	max
Beryllium	1100		2200		150		3700	
Cadmium	9	Cal-modified	3000		37		810	
Chromium	210	a	450	a	100000	e	100000	max, e
Cobalt	--		--		4700		100000	max
Copper	--		--		2900		76000	
Iron	--		--		23000		100000	max
Lead	--		--		400		750	
Manganese	--		--		1800		32000	
Mercury	--		--		23		610	
Molybdenum	--		--		390		10000	
Nickel	150	Cal-modified	--		1600		41000	
Selenium	--		--		390		10000	
Silver	--		--		390		10000	
Thallium	--		--		5.2		130	
Vanadium	--		--		550		14000	
Zinc	--		--		23000		100000	max
Volatile Organic Compounds								
Carbon disulfide	--		--		360		720	sat
Toluene	--		--		520	sat	520	sat
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	--		--		650		3000	sat
2-Methylnaphthalene	--		--		22000	f	100000	g
4-Methylphenol	--		--		310		4400	

TABLE 37 (Continued)

TIER 1 PRELIMINARY REMEDIATION GOALS FOR SOIL AND SEDIMENT
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Soil Cancer PRGs (mg/kg)				Soil Noncancer PRGs (mg/kg)			
	Residential	Notes	Industrial	Notes	Residential	Notes	Industrial	Notes
Semivolatile Organic Compounds (Continued)								
Acenaphthene	--		--		3700		38000	
Benzo(a)anthracene	0.62		2.9		22000	f	100000	g
Benzo(a)pyrene	0.062		0.29		2300	h	54000	h
Benzo(b)fluoranthene	0.62		2.9		2300	i	30000	i
Benzo(g,h,i)perylene	--		--		2300	h	54000	h
Benzo(k)fluoranthene	0.61	Cal-modified	29		2300	i	30000	i
Butylbenzylphthalate	--		--		12000		100000	max
Carbazole	24		120		--		--	
Chrysene	62		290		22000	f	100000	g
Fluoranthene	--		--		2300		30000	
Indeno(1,2,3-cd)pyrene	0.62		2.9		2300	i	30000	i
Phenanthrene	--		--		22000	f	100000	g
Pyrene	--		--		2300		54000	
Pesticides / Polychlorinated Biphenyls								
4,4'-DDD	2.4		17		36	k	730	k
4,4'-DDE	1.7		12		36	k	730	k
4,4'-DDT	1.7		12		36		730	
Aldrin	0.029		0.15		1.8		26	
alpha-BHC	0.09	b	0.59	b	21	l	400	l
alpha-Chlordane	1.6	j	11	j	35	j	670	j
Aroclor-1242	0.22		1		1.1	m	14	m
Aroclor-1248	0.22		1		1.1	m	14	m
Aroclor-1260	0.22		1		1.1	m	14	m
beta-BHC	0.32	c	2.1	c	21	l	400	l
Dieldrin	0.03		0.15		3.1		44	
Endosulfan I	--		--		370	n	5300	n
Endosulfan II	--		--		370	n	5300	n
Endosulfan sulfate	--		--		370	n	5300	n
Endrin	--		--		18		260	
Endrin aldehyde	--		--		18	o	260	o
Endrin ketone	--		--		18	o	260	o
gamma-BHC (Lindane)	0.44	d	2.9	d	21	d	400	d
gamma-Chlordane	1.6	j	11	j	35	j	670	j

TABLE 37 (Continued)

TIER 1 PRELIMINARY REMEDIATION GOALS FOR SOIL AND SEDIMENT
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Soil Cancer PRGs (mg/kg)				Soil Noncancer PRGs (mg/kg)			
	Residential	Notes	Industrial	Notes	Residential	Notes	Industrial	Notes
Pesticides / Polychlorinated Biphenyls (Continued)								
Heptachlor	0.11		0.55		31		440	
Heptachlor epoxide	0.053		0.27		0.79		11	
Methoxychlor	--		--		310		4400	
Pentachlorophenol	3		11		1400		14000	

Notes:

Cal-modified	PRG derived using Cal/EPA toxicity value
Max	Ceiling limit
Sat	Soil saturation limit
a	Value is for total chromium
b	Chemical is listed as alpha-HCH in the PRG table (U.S. Environmental Protection Agency (EPA) 2000, as listed in Appendix F).
c	Chemical is listed as beta-HCH in the PRG table (EPA 2000, as listed in Appendix F).
d	Chemical is listed as gamma-HCH in the PRG table (EPA 2000, as listed in Appendix F).
e	Value is for chromium III
f	Anthracene was used as a surrogate for this chemical
g	Anthracene was used as a surrogate for this chemical
h	Pyrene was used as a surrogate for this chemical
i	Fluoranthene was used as a surrogate for this chemical
j	Chlordane was used as a surrogate for this chemical
k	DDT was used as a surrogate for this chemical
l	Gamma-HCH [Gamma-BHC (Lindane)] was used as a surrogate for this chemical
m	Arochlor-1254 was used as a surrogate for this chemical
n	Endosulfan was used as a surrogate for this chemical
o	Endrin was used as a surrogate for this chemical

TABLE 38

TIER 1 PRELIMINARY REMEDIATION GOALS FOR SURFACE WATER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Residential Tap Water PRGs (µg/L)			
	Cancer PRG	Notes	Noncancer PRG	Notes
Metals				
Aluminum	--		36000	
Antimony	--		15	
Arsenic	0.045		--	
Barium	--		2600	
Beryllium	--		73	
Cadmium	--		18	
Chromium	--		55000	a
Cobalt	--		2200	
Copper	--		1400	
Iron	--		11000	
Lead	--		--	
Manganese	--		880	
Mercury	--		11	
Molybdenum	--		180	
Nickel	--		730	
Selenium	--		180	
Silver	--		180	
Thallium	--		2.4	
Vanadium	--		260	
Zinc	--		11000	
Volatile Organic Compounds				
1,1,1-Trichloroethane	--		540	
1,1-Dichloroethane	2	Cal-modified	810	
Acetone	--		610	
Methylene chloride	4.3		1600	

TABLE 38 (Continued)

TIER 1 PRELIMINARY REMEDIATION GOALS FOR SURFACE WATER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Residential Tap Water PRGs (µg/L)			
	Cancer PRG	Notes	Noncancer PRG	Notes
Semivolatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	4.8		730	
Bromoform	8.5		730	
Phenol	--		22000	
Pesticides / Polychlorinated Biphenyls				
4,4'-DDT	0.2		18	
Aldrin	0.004		1.1	
Dieldrin	0.0042		1.8	
Endosulfan II	--		220	b
Endosulfan sulfate	--		220	b
Endrin	--		11	
gamma-BHC (Lindane)	0.052	c	11	c
Heptachlor	0.015		18	

Notes:

PRG	Preliminary remediation goals
µg/L	Microgram per liter
DDT	Dichlorodiphenyltrichloroethane
BHC	Hexachlorocyclohexane (formerly benzene hexachloride)
Cal-modified	PRG derived using Cal/EPA toxicity value

a	Value is for chromium III
b	Endosulfan was used as a surrogate for this chemical
c	Chemical is listed as gamma-HCH in the PRG table (U.S. Environmental Protection Agency 2000).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 39

HUMAN HEALTH RISK ASSESSMENT RESULTS FOR SOIL AND SEDIMENT: CANCER RISKS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor and RASS	Number of Locations Analyzed[a]	Cancer Risk					Number of Locations with Cancer Risk		
		Minimum	Maximum	Percentile			<1E-06	1E-06 to 1E-04	>1E-04
				50	75	95			
Resident									
RASS 1	169	2.82E-10	8.36E-03	1.92E-04	5.85E-04	2.80E-03	26	27	116
RASS 2	21	1.03E-07	1.35E-03	9.57E-05	1.65E-04	8.87E-04	9	4	8
RASS 3	59	5.91E-10	4.88E-04	2.17E-05	3.65E-05	1.39E-04	22	33	4
RASS 4	21	1.73E-08	5.31E-04	8.82E-05	1.89E-04	3.34E-04	3	9	9
Commercial/Industrial Worker									
RASS 1	169	1.41E-10	1.21E-03	2.76E-05	8.45E-05	4.04E-04	29	102	38
RASS 2	21	3.10E-10	1.96E-04	1.36E-05	2.36E-05	1.28E-04	9	10	2
RASS 3	59	5.33E-11	7.04E-05	3.04E-06	5.19E-06	1.99E-05	24	35	0
RASS 4	21	3.24E-09	7.63E-05	1.26E-05	2.71E-05	4.83E-05	3	18	0
Mosquito Abatement Worker									
RASS 1	140	2.93E-06	3.66E-04	1.10E-05	3.21E-05	1.26E-04	0	128	12
RASS 2	12	3.16E-06	5.93E-05	6.02E-06	2.43E-05	4.81E-05	0	12	0
RASS 3	37	4.79E-10	2.14E-05	1.47E-06	1.97E-06	1.24E-05	9	28	0
RASS 4	18	1.05E-06	2.32E-05	4.29E-06	9.06E-06	1.59E-05	0	18	0

Note:

[a] Number of locations analyzed for cancer risk.

RASS Remedial action subsite

TABLE 40

HUMAN HEALTH RISK ASSESSMENT RESULTS FOR SOIL AND SEDIMENT: HAZARD INDICES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor and RASS	Number of Locations Analyzed[a]	Hazard Index					Number of Locations with Hazard Index	
		Minimum	Maximum	Percentile				
				50	75	95	<1	>1
Resident								
RASS 1	178	0.01	149	4	10	50	38	140
RASS 2	21	0.04	24	2	3	16	9	12
RASS 3	67	0.001	9	0.5	1	4	49	18
RASS 4	21	0.0001	13	2	4	10	6	15
Commercial/Industrial Worker								
RASS 1	178	0.0003	7	0.2	0.7	3	149	29
RASS 2	21	0.003	1	0.1	0.2	0.8	20	1
RASS 3	67	0.00004	0.9	0.04	0.1	0.4	67	0
RASS 4	21	0.00001	0.6	0.2	0.2	0.5	21	0
Mosquito Abatement Worker								
RASS 1	140	0.02	2	0.07	0.2	0.8	135	5
RASS 2	12	0.02	0.4	0.04	0.2	0.3	12	0
RASS 3	7	0.02	0.1	0.04	0.1	0.1	7	0
RASS 4	13	0.02	0.2	0.05	0.08	0.1	13	0

Note:

[a] Number of locations analyzed for hazard index.

RASS Remedial action subsite

TABLE 41

HUMAN HEALTH RISK ASSESSMENT RESULTS FOR SURFACE WATER: CANCER RISKS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor[a] and RASS	Number of Locations Analyzed[b]	Cancer Risk					Number of Locations With Cancer Risk		
		Minimum	Maximum	Percentile			<1E-06	1E-06 to 1E-04	>1E-04
				50	75	95			
Resident									
RASS 1	96	6.7E-05	6.6E-02	3.2E-04	1.6E-03	1.1E-02	0	9	87
RASS 2	6	1.1E-04	1.1E-03	3.8E-04	4.6E-04	9.7E-04	0	0	6
RASS 3	41	4.4E-05	1.6E-03	1.4E-04	2.3E-04	8.2E-04	0	9	32
RASS 4	9	6.2E-05	5.8E-03	3.2E-04	3.9E-03	5.1E-03	0	2	7
Mosquito Abatement Worker									
RASS 1	96	4.0E-09	3.9E-06	1.9E-08	9.3E-08	6.3E-07	92	4	0
RASS 2	6	6.3E-09	6.7E-08	2.2E-08	2.7E-08	5.7E-08	6	0	0
RASS 3	41	2.6E-09	9.6E-08	8.2E-09	1.3E-08	4.9E-08	41	0	0
RASS 4	9	3.7E-09	3.5E-07	1.9E-08	2.3E-07	3.0E-07	9	0	0

Notes:

[a] The commercial/industrial worker receptor was not evaluated for the surface water exposure pathway (see Section 3.2 of Appendix F).

[b] Number of locations analyzed for cancer risk.

PRG Preliminary remediation goal

RASS Remedial action subsite

TABLE 42

HUMAN HEALTH RISK ASSESSMENT RESULTS FOR SURFACE WATER: HAZARD INDICES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor[a] and RASS	Number of Locations Analyzed[b]	Hazard Index					Number of Locations with Hazard Index	
		Minimum	Maximum	Percentile			<1	>1
				50	75	95		
Resident								
RASS 1	106	0.002	129	0.1	0.8	50	82	24
RASS 2	6	5	178	35	61	150	0	6
RASS 3	47	0.004	23	0.3	0.5	5	39	8
RASS 4	9	0.03	17	2	10	14	3	6
Mosquito Abatement Worker								
RASS 1	96	0.000009	0.01	0.00004	0.0004	0.007	96	0
RASS 2	6	0.0004	0.02	0.003	0.006	0.01	6	0
RASS 3	42	0.000006	0.002	0.00002	0.00005	0.0006	42	0
RASS 4	9	0.00002	0.001	0.0005	0.0008	0.001	9	0

Notes:

[a] The commercial/industrial worker receptor was not evaluated for the surface water exposure pathway (see Section 3.2 of Appendix F).

[b] Number of locations analyzed for hazard index.

PRG Preliminary remediation goal

RASS Remedial action subsite

TABLE 43

ANALYTES WITH DETECTION LIMITS EXCEEDING THE RESIDENTIAL PRELIMINARY REMEDIATION GOAL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Number of Samples Analyzed	Number of Samples with Detection Limits			PRG (mg/kg)	Toxicity	Range of Detection Limits (mg/kg)
		> PRG	> 2 x PRG	> 10 x PRG			
2-Nitroaniline	162	47	0	0	3.5	nc	3.80 - 6.90
Aroclor-1221	168	69	8	0	0.22	c	0.23 - 0.56
Aroclor-1232	168	6	0	0	0.22	c	0.23 - 0.28
Aroclor-1242	168	6	0	0	0.22	c	0.23 - 0.28
Aroclor-1248	168	6	0	0	0.22	c	0.23 - 0.28
Aroclor-1254	168	6	0	0	0.22	c	0.23 - 0.28
Aroclor-1260	168	6	0	0	0.22	c	0.23 - 0.28
Arsenic	1,236	17	17	1	0.39	c	1.10 - 4.20
Benzo(a)anthracene	162	117	60	0	0.62	c	0.63 - 2.80
Benzo(a)pyrene	161	151	146	115	0.062	c	0.07 - 2.80
Benzo(b)fluoranthene	161	117	60	0	0.62	c	0.63 - 2.80
Bis(2-chloroethyl)ether	162	152	130	14	0.21	c	0.32 - 2.80
Dibenz(a,h)anthracene	161	157	152	120	0.062	c	0.07 - 2.80
Hexachlorobenzene	162	152	121	0	0.3	c	0.32 - 2.80
Indeno(1,2,3-cd)pyrene	161	119	61	0	0.62	c	0.63 - 2.80
Pentachlorophenol	162	61	4	0	3.0	c	3.10 - 6.90
Thallium	165	1	1	0	5.2	nc	22 - 22
Toxaphene	168	96	30	0	0.44	c	0.45 - 1.40

Notes:

c Carcinogen

mg/kg Milligram per kilogram

nc Noncarcinogen

PRG Preliminary remediation goal (U.S. Environmental Protection Agency 2000)

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 44

TIER 2 CHEMICALS OF POTENTIAL CONCERN AND RISK-BASED SCREENING CONCENTRATIONS FOR SOIL AND SEDIMENT FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Chemical of Potential Concern	Cancer PRG (mg/kg)	Noncancer PRG (mg/kg)
Aldrin	0.39	70
Aroclor-1242	2.5	36
Aroclor-1248	2.5	36
Arsenic	8.9	1,426
Benzo(a)pyrene	0.74	57,026
Cadmium	33,209	4,149
Manganese	--	100,000[a]
Mercury	--	2,555
Selenium	--	42,583
Thallium	--	562
Zinc	--	100,000[a]

Notes:

PRG Preliminary remediation goal

mg/kg Milligram per kilogram

-- Not evaluated

a Value given is a non-risk-based "ceiling limit" or "maximum" concentration given as 100,000 mg/kg (ppm) as recommended in the Region 9 PRG Table (EPA 2000).

Source:

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Posted November 3. http://www.epa.gov/region09/waste/sfund/prg/

TABLE 45

TIER 2 CHEMICALS OF POTENTIAL CONCERN AND RISK-BASED SCREENING CONCENTRATIONS FOR SURFACE WATER FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Chemical of Potential Concern	Cancer PRG (µg/L)	Noncancer PRG (µg/L)
1,1-Dichloroethane	--	8.27E+08
Aldrin	5.14E+04	9.36E+06
Aluminum	--	4.06E+08
Antimony	--	1.62E+05
Arsenic	7.57E+02	1.22E+05
Bis(2-ethylhexyl)phthalate	1.88E+09	1.88E+11
Cadmium	--	1.84E+05
Copper	--	1.50E+07
Dieldrin	6.62E+05	1.89E+08
Heptachlor	1.43E+06	1.15E+09
Iron	--	1.22E+08
Manganese	--	9.73E+06
Methylene chloride	1.21E+06	1.94E+08
Nickel	--	2.70E+09
Thallium	--	2.68E+04
Vanadium	--	2.84E+06
Zinc	--	2.03E+08

Notes:

PRG Preliminary remediation goal

µg/L Microgram per liter

-- Not evaluated

TABLE 46

SUMMARY OF RISK QUESTIONS, ASSESSMENT AND MEASUREMENT ENDPOINTS, AND UNCERTAINTIES FOR PLANTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor Group	Risk Questions	Assessment Endpoint	Measurement Endpoints	Uncertainties
1° Producers – Upland Plants	1. Are concentrations of COCs in upland soils present at levels above ORNL plant benchmarks or other effects levels reported in the literature? 2. Are plants bioaccumulating contaminants at levels that may pose a risk to their survival, growth, and reproduction? 3. Are indicators of native plant assemblages, such as percent cover and mean height, correlated with sitewide concentrations of metals?	Sufficient rates of survival, growth, and germination to sustain populations of upland plants	1. UCL_{95} of the mean concentrations of contaminants in upland soil 2. UCL_{95} of the mean concentrations of contaminants in upland plant tissue 3. Plant community measures (percent cover and plant height)	1. Difference between bioavailability and form of chemicals used to derive benchmark and those measured on site 2. Difference between species of plants on site and those that were used in development of benchmarks
1° Producers – Wetland Plants	1. Are concentrations of COCs in wetland sediments present at levels above ORNL plant benchmarks or other effects levels reported in the literature? 2. Are plants bioaccumulating contaminants at levels that may pose a risk to their survival, growth, and reproduction? 3. Are indicators of native plant assemblages, such as percent cover and mean height, correlated with sitewide concentrations of metals?	Sufficient rates of survival, growth, and germination to sustain populations of wetland plants	1. UCL_{95} of the mean concentrations of contaminants in wetland sediment 2. UCL_{95} of the mean concentrations of contaminants in wetland plant tissue 3. Plant community measures (percent cover and plant height)	1. Difference between bioavailability and form of chemicals used to derive benchmark and those measured on site 2. Difference between species of plants on site and those that were used in development of benchmarks

Notes:

COC Chemical of concern
ORNL Oak Ridge National Laboratory
UCL_{95} one-side 95 percent upper confidence limit on the arithmetic mean

TABLE 47

HYPOTHESIS TESTS AND QUALITATIVE EVALUATIONS FOR ASSESSING RISK TO PLANTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor Group	Measurement Endpoint	Hypothesis or Qualitative Evaluation
Upland Plants	Concentration of contaminants in upland soil	H_0: Concentration of COCs in upland soil greater than ORNL plant benchmarks
	Concentration of contaminants in upland plant tissue	Whole plant tissue (stems, leaves, roots) concentrations were compared with effects levels reported in the literature. Individual plant species evaluated included: *Avena fatua, Bromus diandrus, Bromus hordeaceus, Centaurea solstitialis, Convolvulus arvensis, Erodium cicutarium, Hordeum marinum* ssp. *Gussoneanum, Hordeum marinum* ssp. *Gussoneanum,* and *Vicia sativa ssp. sativa*
	Plant community measures (percent cover and plant height)	No threshold values exist; assessment was based evaluating trends between plant community metrics and metals along a gradient of increasing metal concentration
Wetland Plants	Concentration of contaminants in wetland sediments	H_0: Concentration of COCs in wetland sediment greater than ORNL plant benchmarks
	Concentration of contaminants in wetland plant tissue	Whole plant tissue concentrations (stems, leaves, roots) were compared with effects levels reported in the literature. Individual plant species evaluated included: *Atriplex patula var. patula, Cressa truxillenis, Distichlis spicata, Epilobium brachycarpum, Frankenia salina, Grindelia hirsutula* var. *hirsutula, Jaumea carnosa, Juncus balticus, Lactuca serriola*, *Lepidium latifolium*, *Lolium perenne, Potentilla anserina* ssp. *Pacifica*, *Salicornia virginica*, *Scirpus americanus*, *Triglochin maritime*, and *Vulpia myuros*. For *Salicornia virginica,* above ground tissue was also evaluated separately.
	Plant community measures (percent cover and plant height)	No threshold values exist; assessment were based evaluating trends between plant community metrics and metals along a gradient of increasing metal concentration

Notes:

COC Chemical of concern
H_0 Null Hypothesis
ORNL Oak Ridge National Laboratory

TABLE 48

SUMMARY OF RISK QUESTIONS, ASSESSMENT AND MEASUREMENT ENDPOINTS, AND UNCERTAINTIES FOR AQUATIC INVERTEBRATES AND FISH FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Risk Question	Assessment Endpoint	Measurement Endpoints	Uncertainties and Data Gaps
1° and 2° Consumers – Benthic Invertebrates	1. Do contaminants in surface water exceed water quality benchmarks? 2. Do contaminants in sediments exceed the ER-M? 3. Are aquatic invertebrates bioaccumulating contaminants at levels that pose a risk to survival, growth, and reproduction? 4. Is survival of the amphipod *Eohaustorius estuarius* at contaminated sites less than the RWQCB reference envelope? 5. Are survival and reburial for the amphipod *Hyalella azteca* at contaminated sites less than the survival and growth in laboratory controls?	Sufficient rates of survival, growth, and reproduction to sustain populations of benthic invertebrates	1. Concentration of contaminants in surface water 2. Concentration of contaminants in sediments 3. Concentration of contaminants in clam, amphipod, crayfish, and damselfly larvae 4. Measures of survival from 10-day whole sediment toxicity tests using the amphipod *Eohaustorius estuarius* 5. Measures of survival and growth from 14-day whole sediment toxicity tests using the amphipod *Hyalella azteca*	1. Interspecies variability in sensitivity to chemicals and extrapolation of bioassay results for test species to assessment endpoints 2. A variety of noncontaminant factors that could affect benthic community measures throughout the site
2° Consumer – Fish	1. Do contaminants in surface water exceed water quality benchmarks? 2. Do contaminants in sediments exceed the ER-M? 3. Are fish bioaccumulating contaminants at levels that pose a risk to survival, growth, and reproduction? 4. Is percent hatchability for the topsmelt (*Atherinops affinis*) at contaminated sites less than percent hatchability observed in laboratory controls?	Sufficient rates of survival, growth, and reproduction to sustain populations of resident fish	1. Concentration of contaminants in surface water 2. Concentration of contaminants in sediments 3. Concentrations of contaminants in fish tissue 4. Measures of percent hatch from 12-day sediment-water interface toxicity tests using the topsmelt (A*therinops affinis*)	1. Interspecies variability in sensitivity to chemicals and extrapolation of bioassay results for test species to assessment endpoints

Notes:

ER-M Effects-range median
RWQCB California Regional Water Quality Control Board
SFEI San Francisco Estuary Institute

TABLE 49

HYPOTHESIS TESTS AND QUALITATIVE EVALUATIONS FOR ASSESSING RISK TO AQUATIC INVERTEBRATES AND FISH
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Medium	Test	Measurement Endpoint	Hypothesis or Qualitative Evaluation
Water	Water Chemistry	Concentration of contaminants in surface water	H_0: Concentrations within a spatial unit are greater than the water quality benchmarks
Sediment	Sediment chemistry	ER-M quotient	H_0: Site ER-M quotient greater than effects thresholds (listed in Table 54)
	Amphipod	Survival	H_0: Site survival less than RWQCB reference envelope edge (listed in Table 54)
	Eohaustorius estuarius (10-day)	Reburial	Reburial was evaluated by calculating a separate measure of "effective survival"
	Amphipod *Hyalella azteca* (14-day)	Survival	H_0: Site survival less than control survival
		Growth	H_0: Site growth less than control growth
	Benthic community	Benthic community measurements[1]	H_0: Benthic community metrics are correlated with increasing measures of risk based on the mean ER-M quotient
	Bioaccumulation	Clam tissue concentration	H_0: Tissue concentrations of contaminants exceed effects-levels reported in the literature
Sediment-water Interface	Topsmelt *Atherinops affinis* (12-day)	Percent hatchability	H_0: Site hatchability less than control hatchability

Notes:

ER-M Effects-range median
H_0 Null hypothesis
RWQCB California Regional Water Quality Control Board
1 Will use benthic community metrics developed by San Francisco Estuary Institute in draft final report, if applicable.

TABLE 50

SUMMARY OF RISK QUESTIONS, ASSESSMENT AND MEASUREMENT ENDPOINTS, AND UNCERTAINTIES FOR BIRDS AND MAMMALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group (Trophic Guild)	Risk Questions	Assessment Endpoints	Measurement Endpoints	Uncertainties and Data Gaps
2° Consumer – Aquatic Avian Omnivores	Do site-specific modeled doses to representative species, such as the Mallard, exceed the Navy high or low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of avian aquatic omnivores	Daily chemical dose and HQs (dose/TRV) for the Mallard (*Anas platyrhynchos*)	1. Doses calculated on the basis of concentrations in field-collected fish, invertebrate, tadpole, and plant tissues; actual diet may differ from assumed diet 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species
2° Consumers – Carnivorous Shorebirds	Do site-specific modeled doses to representative species, such as the California Black Rail, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain individual shorebirds	Daily chemical dose and HQs (dose/TRV) for the California Black Rail (*Laterallus jamaicensis coturniculus*)	1. Doses calculated on the basis of concentrations in amphipod tissues; actual diets may differ 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species
2° Consumers – Omnivorous Passerines	Do site-specific modeled doses to representative species, such as the Suisun Song Sparrow, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of carnivorous passerines and individual Suisun Song Sparrows	Daily chemical dose and HQs (dose/TRV) for the Suisun Song Sparrow (*Melospiza melodia maxillaris*)	1. Doses calculated on the basis of concentrations in amphipod, pickleweed and bulrush tissues; actual diets may differ 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species

TABLE 50 (Continued)

SUMMARY OF RISK QUESTIONS, ASSESSMENT AND MEASUREMENT ENDPOINTS, AND UNCERTAINTIES FOR BIRDS AND MAMMALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group (Trophic Guild)	Risk Questions	Assessment Endpoints	Measurement Endpoints	Uncertainties and Data Gaps
2°/3° Consumers – Raptors	Do site-specific modeled doses to representative species, such as the Northern Harrier and American Kestrel, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of raptors	Daily chemical dose and HQs (dose/TRV) for the Northern Harrier (*Circus cyaneus*) and American Kestrel (*Falco sparverius*)	1. Doses calculated on the basis of concentrations in field-collected mice and voles were used to estimate daily doses to kestrels and harriers; actual diet may differ from assumed diet 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species
3° Consumer – Wading Birds	Do site-specific modeled doses to representative species, such as the Great Blue Heron, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of piscivorous birds	Daily chemical dose and HQs (dose/TRV) for the Great Blue Heron (*Ardea herodias*)	1. Doses calculated on the basis of concentrations in field-collected fish, tadpole, crayfish, and rodent tissues; actual diet may differ 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species
1° Consumers – Herbivorous Mammals	Do site-specific modeled doses to representative species, such as the salt marsh harvest mouse, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of herbivorous mammals and individual salt marsh harvest mice	Daily chemical dose and HQs (dose/TRV) for the salt marsh harvest mouse (*Reithrodontomys raviventris*)	1. Doses calculated on the basis of concentrations in pickleweed plants; actual diet may differ 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species
3° Consumers – Aquatic Carnivorous Mammals	Do site-specific modeled doses to representative species, such as the river otter, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of aquatic carnivorous mammals	Daily chemical dose and HQs (dose/TRV) for the river otter (*Lutra Canadensis*)	1. Doses calculated on the basis of concentrations in fish, clam, and crayfish tissues; actual diet may differ 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species

TABLE 50 (Continued)

SUMMARY OF RISK QUESTIONS, ASSESSMENT AND MEASUREMENT ENDPOINTS, AND UNCERTAINTIES FOR BIRDS AND MAMMALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group (Trophic Guild)	Risk Questions	Assessment Endpoints	Measurement Endpoints	Uncertainties and Data Gaps
3° Consumers – Terrestrial Carnivorous Mammals	Do site-specific modeled doses to representative species, such as the gray fox, exceed the Navy high and low TRVs?	Sufficient rates of survival, growth, and reproduction to sustain populations of terrestrial carnivorous mammals	Daily chemical dose and HQs (dose/TRV) for the gray fox (*Urocyon cinereoargenteus*)	1. Doses calculated on the basis of concentrations in field-collected mice and voles; actual diets may differ 2. Bioavailability of site contaminants compared with those in studies on which TRVs were based 3. Species sensitivity varies; laboratory test animal may not be suitable surrogate for wildlife species

Notes:

HQ Hazard quotient

TRV Toxicity reference value

TABLE 51

HYPOTHESIS TESTS AND QUALITATIVE EVALUATIONS FOR ASSESSING RISK TO BIRDS AND MAMMALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor Group	Representative Species for Assessment Endpoint	Measurement Endpoints	Hypothesis
Aquatic Avian Consumers	Mallard	Daily chemical dose and HQs (dose/TRV) for the Mallard	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Carnivorous Shorebirds	California Black Rail	Daily chemical dose and HQs (dose/TRV) for the California Black Rail	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Omnivorous Passerines	Suisun Song Sparrow	Daily chemical dose and HQs (dose/TRV) for the Suisun Song Sparrow	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Carnivorous Raptors	Northern Harrier and American Kestrel	Daily chemical dose and HQs (dose/TRV) for the Northern Harrier and American Kestrel	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Carnivorous Wading Birds	Great Blue Heron	Daily chemical dose and HQs (dose/TRV) for the Great Blue Heron	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Herbivorous Mammals	Salt Marsh Harvest Mouse	Daily chemical dose and HQs (dose/TRV) for the salt marsh harvest mouse	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Aquatic Carnivores	River Otter	Daily chemical dose and HQs (dose/TRV) for the river otter	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1
Terrestrial Carnivores	Gray Fox	Daily chemical dose and HQs (dose/TRV) for the gray fox	H_0: HQs in dose model (average dose/low TRV; average dose/high TRV) greater than 1

Notes:

H_0 Null hypothesis
HQ Hazard quotient
TRV Toxicity reference value

TABLE 52

OAK RIDGE NATIONAL LABORATORY
PLANT TOXICITY BENCHMARKS FOR METALS IN SOIL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	ORNL Plant Toxicity Benchmark (mg/kg)[a]
Inorganic Chemicals	
Aluminum	50.00
Antimony	5.00
Arsenic	10.00
Barium	500.00
Beryllium	10.00
Cadmium	4.00
Chromium	1.00
Cobalt	20.00
Copper	100.00
Lead	50.00
Manganese	500.00
Mercury	0.30
Molybdenum	2.00
Nickel	30.00
Selenium	1.00
Silver	2.00
Thallium	1.00
Tin	50.00
Vanadium	2.00
Zinc	50.00

Notes:

mg/kg Milligrams per kilogram
ORNL Oak Ridge National Laboratory

a Efroymson, R.A., and others. 1997. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision." ES/ER/TM-85/. ORNL, Oak Ridge, Tennessee. 128 Pages.

TABLE 53

SEDIMENT SCREENING BENCHMARKS FOR ASSESSING RISK TO FISH AND AQUATIC INVERTEBRATES
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	RWQCB (1998) [a] SF Bay Ambient	Tidal Area Ambient[b] (99th Percent UCL)	Long and others (1995) [c]	
			ER-L	ER-M
Inorganics (mg/kg dry weight)				
Aluminum	NA	27,300	NA	NA
Antimony	NA	2.2	2*	25*
Arsenic	15.3	27	8.2	70
Barium	NA	530	NA	NA
Beryllium	NA	0.18	NA	NA
Cadmium	0.33	1.9	1.2	9.6
Chromium	112	82.1	81	370
Cobalt	NA	36	NA	NA
Copper	68.1	81	34	270
Iron	NA	90,000	NA	NA
Lead	43.2	95	46.7	218
Manganese	NA	1,500	NA	NA
Mercury	0.43	0.32	0.15	0.71
Molybdenum	NA	6.6	NA	NA
Nickel	112	120	20.9	51.6
Selenium	0.64	NA	0.7*	1.4*
Silver	0.58	NA	1	3.7
Thallium	NA	2.2	NA	NA
Vanadium	NA	96	NA	NA
Zinc	158	264	150	410
PCBs/Pesticides (µg/kg dry weight)				
Total PCBs	14.8**	NA	22.7	180
4,4'-DDD	NA	NA	2.0*	20*
4,4'-DDE	NA	NA	2.2	27
4,4'-DDT	NA	NA	1*	7*
Total DDTs	7.0	NA	1.58	46.1

Notes:

a California Regional Water Quality Control Board. 1998. "Ambient Concentrations of Toxic Chemicals in San Francisco Bay Sediments."

b PRC Environmental Management, Inc. 1996b. "Technical Memorandum, Ambient Metal Concentrations in the Tidal Area Soils."

c Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management.* Volume 19. Number 1. Pages 81-97.

* National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seatttle, Washington. (also cited as Long and Morgan 1990.)

** Bioaccumulation based number

DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects-range low
ER-M Effects-range median
PCB Polychlorinated biphenyl
µg/kg Microgram per kilogram
mg/kg Milligram per kilogram
NA Not available
RWQCB California Regional Water Quality Control Board
UCL Upper confidence limit

TABLE 54

DECISION CRITERIA FOR LINES OF EVIDENCE FOR INORGANIC CHEMICALS BASED ON MAGNITUDE OF RESPONSE FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Assessment Category	Line of Evidence	→ Increasing Evidence of Risk[a] →			
			Below Threshold Level of Concern		Above Threshold Level of Concern	
			0	1	2	3
Upland and Wetland Plants	Chemistry	Concentrations of metals in sediment or soil (based on 20 metals)[b]	≤ 1 metal that exceeds ORNL benchmark	2-4 metals exceed ORNL benchmarks	5-11 metals exceed ORNL benchmarks or 1 metal at 5X ORNL benchmark	≥ 12 metals exceed ORNL benchmarks or 1 metal at 10X ORNL benchmark
		Concentrations of metals in sediment or soil (based on 6 metals)[b]	≤ 1 metal that exceeds ORNL benchmark	2 metals exceed ORNL benchmarks	3 metals exceed ORNL benchmarks or 1 metal at 5X ORNL benchmark	≥ 4 metals exceed ORNL benchmarks or 1 metal at 10X ORNL benchmark
	Bioaccumulation	Concentrations of metals in plant tissue[c]	Tissue concentrations of metals were compared to effects-levels reported in the literature. BAFs were calculated for collocated soil or sediment and plant tissue samples; there are no established benchmarks for interpreting BAFs, therefore, results were evaluated qualitatively and presented in summary tables and figures.			
	Other	Plant community metrics[c]	Pickleweed percent cover was compared along a gradient of metal concentrations across the site.			

TABLE 54 (Continued)

DECISION CRITERIA FOR LINES OF EVIDENCE FOR INORGANIC CHEMICALS BASED ON MAGNITUDE OF RESPONSE FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Assessment Category	Line of Evidence	→ Increasing Evidence of Risk[a] →			
			Below Threshold Level of Concern		Above Threshold Level of Concern	
			0	1	2	3
Fish and Aquatic Invertebrates	Chemistry	Concentrations of metals in surface water (based on 20 metals)[b]	No metals exceed acute AWQC		1-2 metals exceed acute AWQC or 1 metal at 2X acute AWQC	≥ 3 metals exceed acute AWQC or 1 metal at 4X acute AWQC
		Concentrations of metals in surface water (based on six metals)[b]	No metals exceed acute AWQC		1 metal exceeds acute AWQC	≥ 2 metals exceed acute AWQC or 1 metal at 4X acute AWQC
		Concentrations of metals in surface water (based on 20 metals)[b]	No metals exceed chronic AWQC	1-2 metals exceed chronic AWQC	3-4 metals exceed chronic AWQC or 1 metal at 2X chronic AWQC	≥ 5 metals exceed chronic AWQC or 1 metal at 4X chronic AWQC

TABLE 54 (Continued)

DECISION CRITERIA FOR LINES OF EVIDENCE FOR INORGANIC CHEMICALS BASED ON MAGNITUDE OF RESPONSE FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Assessment Category	Line of Evidence	→ Increasing Evidence of Risk[a] →			
			Below Threshold Level of Concern		Above Threshold Level of Concern	
			0	1	2	3
Fish and Aquatic Invertebrates	Chemistry	Concentrations of metals in surface water (based on six metals) [b]	No metals exceed chronic AWQC	1 metal exceeds chronic AWQC	2 metals exceed chronic AWQC or 1 metal at 2X chronic AWQC	≥ 3 metals exceed chronic AWQC or 1 metal at 4X chronic AWQC
		Concentrations of metals in sediments (based on 20 metals)[b]	$ER\text{-}M_q < 0.11$[d] or All metals ≤ ER-M*	$ER\text{-}M_q \geq 0.11$ but ≤ 0.5 [d] or 1-2 metals exceed ER-M*	$ER\text{-}M_q > 0.5$ but ≤ 1.5 [d] or 1 metal at 5X ER-M; 3-4 metals exceed ER-M	$ER\text{-}M_d > 1.5$ [b]; 1 metal at 10X ER-M; or ≥ 5 metals exceed ER-M
		Concentrations of metals in sediments (based on six metals)[b]	$ER\text{-}M_q < 0.11$[d] or All metals < ER-M*	$ER\text{-}M_q \geq 0.11$ but ≤ 0.5 [d] or 1 metal exceeds ER-M*	$ER\text{-}M_q > 0.5$ but ≤ 1.5 [d] or 1 metal at 5X; 2 metals exceed ER-M	$ER\text{-}M_d > 1.5$ [b]; 1 metal at 10X ER-M; or 1 metal at 10X ER-M; >2 metals exceed ER-M

TABLE 54 (Continued)

DECISION CRITERIA FOR LINES OF EVIDENCE FOR INORGANIC CHEMICALS BASED ON MAGNITUDE OF RESPONSE FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Assessment Category	Line of Evidence	→ Increasing Evidence of Risk[a] →			
			Below Threshold Level of Concern		Above Threshold Level of Concern	
			0	1	2	3
Fish and Aquatic Invertebrates	Toxicity	Topsmelt 12-day sediment water interface bioassay % hatchability[b]	Hatchability > 90% of laboratory controls	Hatchability > 80% but ≤ 90% of laboratory controls	Hatchability ≥ 65% but ≤ 80% of laboratory controls	< 65% of hatchability measured in controls
		Eohaustorius 10-day whole-sediment bioassay % survival[b,1]	Survival > 80%	Survival and reburial > 68%* but ≤ 80% *Corresponds to 95 percent lower confidence limit of 8th percentile of RWQCB reference envelope[e]	Survival and reburial ≥ 50% but ≤ 68%	Survival and reburial < 50%
		Hyalella 14-day whole-sediment bioassay[b,1] % survival[b,1]	Survival > 90% relative to mean survival in lab controls	Survival > 80% but ≤ 90% relative to mean survival in lab controls	Survival ≥ 65% but ≤ 80% relative to mean survival in lab controls	< 65% survival relative to mean survival in lab controls

TABLE 54 (Continued)

DECISION CRITERIA FOR LINES OF EVIDENCE FOR INORGANIC CHEMICALS BASED ON MAGNITUDE OF RESPONSE FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Assessment Category	Line of Evidence	→ Increasing Evidence of Risk[a] →			
			Below Threshold Level of Concern		Above Threshold Level of Concern	
			0	1	2	3
Fish and Aquatic Invertebrates	Toxicity	*Hyalella* 14-day whole-sediment bioassay % growth[b,1]	Growth >90% relative to mean growth in lab controls	Growth >80% but ≤ 90% relative to mean growth in lab controls	Growth ≥ 65 % but ≤ 80% relative to mean growth in lab controls	< 65% growth relative to mean growth in lab controls
	Bioaccumulation	Concentrations of metals in fish and aquatic invertebrate tissue[c]	Tissue concentrations of metals were compared to effects-levels reported in the literature (Jarvinen and Ankley 1999). BAFs were calculated for collocated sediment and tissue samples; there are no benchmarks for interpreting BAFs, therefore, results were evaluated qualitatively and summarized in tables and figures.			
	Bioavailability	Concentrations of metals in sediment and soil extractions (WET)[c]	The fraction of total metals recovered in soil or sediment leachate (WET_{acid}, WET_{water}) were calculated and summarized in tables. Metal concentrations in leachate provided a qualitative measure of the potential bioavailability of different metals across sampling locations.			
		Concentrations of metals in sediment porewater[c]	The fraction of total metals measured in porewater were calculated and summarized in tables. Porewater concentrations of metals provided a qualitative measure of the potential bioavailability of different metals across sampling locations.			

TABLE 54 (Continued)

DECISION CRITERIA FOR LINES OF EVIDENCE FOR INORGANIC CHEMICALS BASED ON MAGNITUDE OF RESPONSE FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptor Group	Assessment Category	Line of Evidence	→ Increasing Evidence of Risk[a] →			
			Below Threshold Level of Concern		Above Threshold Level of Concern	
			0	1	2	3
Fish and Aquatic Invertebrates	Bioavailability	SEM-AVS[c]	SEM-AVS was evaluated at a subset of locations selected for additional amphipod toxicity testing. SEM-AVS was used primarily to interpret bioassay results.			
Birds and Mammals	Toxicity	Modeled dose/TRV[b]	Dose < TRV_{low}	Dose ≥ TRV_{low} and < TRV_{high}	Dose ≥ TRV_{high}	Dose ≥ 10X TRV_{low}
			Ambient HQs will be calculated for risk management.			

Notes:

a Unless a specific reference is provided, decision criteria were based on professional judgment and will be negotiated with the agencies.

b Quantitative line-of-evidence based on established benchmark.

c Qualitative line-of-evidence based on professional judgment.

d Long, E.R., and D.D. MacDonald. 1998. "Recommended Uses of Empirically-derived Sediment Quality Guidelines for Marine and Estuarine Ecosystems." *Human and Ecological Risk Assessment*. Volume 4. Number 5.

e State of California Water Resources Control Board. 1998. "Evaluation and Use of Sediment Reference Sites and Toxicity Tests in San Francisco Bay. Final Report." April.

1 Further interpretation of test results will be made by comparison to a proposed reference location that will represent a nominally impacted sediment location at the site. The performance criterion for using the reference data will be a survival rate of 80 percent relative to laboratory controls. Data from all sampling locations will be combined and concentration-response curves will be generated to identify threshold effects levels.

* Concentrations below the ER-M may indicate some risk.

>	Greater than	AVS	Acid volatile sulfide
<	Less than	HQ	Hazard quotient
≥	Greater than or equal to	SEM	Simultaneously extracted metals
≤	Less than or equal to	WET	Waste extraction text

TABLE 55

SCREEN FOR SEDIMENT METALS DATA COLLECTED IN OCTOBER 2000
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Site Detection Frequency		Site Summary Statistics					LITIGATION AREA COMPARISONS TO AMBIENT									TOXICITY EVALUATION					
									Ambient Detection Frequency		Concord Tidal Area Ambient Site Greater than Ambient?					San Francisco Bay Ambient		Benchmarks		Number of Locations Greater than Benchmark		UCL_{95} Greater than Benchmark?	
Habitat	Metal	Detects	Locations	Mean (mg/kg)	Median (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)	UCL_{95} (mg/kg)	Detects	Locations	WRS[1]	FET[1]	Quantile[2]	Max > 99th?[3]	99th [4]	Benchmark[5]	Site > Ambient?[6]	ER-L (mg/kg)	ER-M (mg/kg)	ER-L	ER-M	ER-L	ER-M
Slough and Ditches	Aluminum	11	11	28,672.73	27,900.00	16,500.00	38,800.00	32,189.44	61	61	**Y**	NA	--	NA	27,300	--	--	--	--	--	--	--	--
	Antimony	0	11	1.65	1.60	1.00	2.80	1.94	11	46	NA	N	N	NA	2.2	--	--	2	25	2	0	N	N
	Arsenic	11	11	150.21	71.40	34.80	385.00	227.02	49	57	**Y**	NA	--	NA	27	15.3	**Y**	8.2	70	11	6	**Y**	**Y**
	Barium	11	11	128.72	106.00	75.80	262.00	160.52	59	59	**Y**	NA	--	NA	530	--	--	--	--	--	--	--	--
	Beryllium	9	11	0.53	0.57	0.17	0.94	0.65	6	61	NA	**Y**	**Y**	NA	0.18	--	--	--	--	--	--	--	--
	Cadmium	11	11	16.75	11.80	4.30	63.80	26.26	6	61	NA	**Y**	**Y**	NA	1.9	0.33	**Y**	1.2	9.6	11	7	**Y**	**Y**
	Chromium	11	11	67.34	67.50	29.10	98.00	77.32	55	57	**Y**	NA	--	NA	82.1	112	N	81	370	1	0	N	N
	Cobalt	11	11	24.55	19.10	13.50	67.60	32.94	57	57	**Y**	NA	--	NA	36	--	--	--	--	--	--	--	--
	Copper	11	11	299.03	129.00	95.70	892.00	470.99	56	60	**Y**	NA	--	NA	81	68.1	**Y**	34	270	11	3	**Y**	**Y**
	Iron	11	11	42,963.64	39,100.00	29,200.00	67,400.00	48,917.95	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Lead	11	11	60.60	54.30	34.80	108.00	73.21	55	55	**Y**	NA	--	NA	95	43.2	**Y**	46.7	218	7	0	**Y**	N
	Manganese	11	11	1,093.91	498.00	196.00	6,110.00	2,019.10	59	59	**Y**	NA	--	NA	1,500	--	--	--	--	--	--	--	--
	Mercury	7	11	0.27	0.26	0.15	0.37	0.31	20	60	NA	N	Y	NA	0.32	0.43	N	0.15	0.71	9	0	**Y**	N
	Molybdenum	8	11	2.96	1.50	0.55	9.20	4.50	29	59	N	NA	N	NA	6.6	--	--	--	--	--	--	--	--
	Nickel	11	11	71.55	70.70	38.60	101.00	80.83	60	60	**Y**	NA	--	NA	120	112	N	20.9	51.6	11	10	**Y**	**Y**
	Selenium	4	11	1.25	0.65	0.28	3.70	1.89	2	61	NA	**Y**	N	NA	--	0.64	**Y**	0.7	1.4	5	4	**Y**	**Y**
	Silver	0	11	0.71	0.75	0.19	1.40	0.90	0	61	NA	N	N	NA	--	0.58	**Y**	1	3.7	1	0	N	N
	Thallium	0	11	0.50	0.50	0.22	0.90	0.61	5	60	NA	N	N	NA	2.2	--	--	--	--	--	--	--	--
	Vanadium	11	11	86.15	80.30	60.80	137.00	97.33	59	57	**Y**	NA	--	NA	96	--	--	--	--	--	--	--	--
	Zinc	11	11	2,293.09	2,320.00	804.00	4,300.00	2,834.49	53	57	**Y**	NA	--	NA	264	158	**Y**	150	410	11	11	**Y**	**Y**
Slough Reference	Aluminum	3	3	32,500.00	29,500.00	27,500.00	40,500.00	NA	61	61	NA	NA	NA	**Y**	27,300	--	--	--	--	0	0	--	--
	Antimony	0	3	1.23	1.20	0.60	1.90	NA	11	46	NA	NA	NA	N	2.2	--	--	2	25	0	0	--	--
	Arsenic	3	3	18.30	17.20	13.20	24.50	NA	49	57	NA	NA	NA	N	27	15.3	**Y**	8.2	70	3	0	--	--
	Barium	3	3	93.70	92.00	81.10	108.00	NA	59	59	NA	NA	NA	N	530	--	--	--	--	--	--	--	--
	Beryllium	3	3	0.89	0.84	0.72	1.10	NA	6	61	NA	NA	NA	**Y**	0.18	--	--	--	--	--	--	--	--
	Cadmium	0	3	0.06	0.05	0.04	0.11	NA	6	61	NA	NA	NA	N	1.9	0.33	**Y**	1.2	9.6	0	0	--	--
	Chromium	3	3	96.37	92.10	79.00	118.00	NA	55	57	NA	NA	NA	**Y**	82.1	112	N	81	370	2	0	--	--
	Cobalt	3	3	21.67	23.40	16.80	24.80	NA	57	57	NA	NA	NA	N	36	--	--	--	--	--	--	--	--
	Copper	3	3	68.00	70.00	59.60	74.40	NA	56	60	NA	NA	NA	N	81	68.1	**Y**	34	270	3	0	--	--
	Iron	3	3	45,833.33	47,500.00	37,600.00	52,400.00	NA	--	--	NA	NA	NA	--	--	--	--	--	--	--	--	--	--
	Lead	3	3	26.97	25.90	25.70	29.30	NA	55	55	NA	NA	NA	N	95	43.2	**Y**	46.7	218	0	0	--	--
	Manganese	3	3	586.67	537.00	475.00	748.00	NA	59	59	NA	NA	NA	N	1,500	--	--	--	--	--	--	--	--
	Mercury	3	3	0.29	0.28	0.27	0.32	NA	20	60	NA	NA	NA	N	0.32	0.43	N	0.15	0.71	3	0	--	--
	Molybdenum	2	3	0.93	1.00	0.40	1.40	NA	29	59	NA	NA	NA	N	6.6	--	--	--	--	--	--	--	--
	Nickel	3	3	99.20	97.30	77.30	123.00	NA	60	60	NA	NA	NA	**Y**	120	112	**Y**	20.9	51.6	3	3	--	--
	Selenium	0	3	0.27	0.27	0.25	0.29	NA	2	61	NA	NA	NA	--	--	0.64	--	0.7	1.4	0	0	--	--
	Silver	0	3	0.36	0.36	0.34	0.40	NA	0	61	NA	NA	NA	--	--	0.58	--	1	3.7	0	0	--	--
	Thallium	0	3	0.25	0.25	0.23	0.27	NA	5	60	NA	NA	NA	N	2.2	--	--	--	--	--	--	--	--
	Vanadium	3	3	120.67	116.00	106.00	140.00	NA	59	57	NA	NA	NA	**Y**	96	--	--	--	--	--	--	--	--
	Zinc	3	3	176.67	166.00	158.00	206.00	NA	53	57	NA	NA	NA	N	264	158	**Y**	150	410	3	0	--	--

Notes: **Bold** indicates all cases where the site concentration or detection frequency exceeded the ambient value for each of the compariso

1 WRS test used to conduct two population tests for sample sizes greater than 10 and detection frequencies greater than or equal to 50 percent; FET used to compare proportion of detected samples when detection frequencies are less than 50 percent.

2 Quantile test used to compare right-hand tails of site and ambient distributions for all cases where the WRS test passed (site not greater than ambient) and for all comparisons conducted using the FET.

3 The maximum site concentration was compared with the 99th percentile of the Concord Tidal Area ambient distribution for all cases where the sample size was less than or equal to 3.

4 The 99th percentile (nonparametric) of the Concord Tidal Area ambient distribution (PRC 1996a).

5 The 85th percentile of the distribution for RWQCB ambient data set for San Francisco Bay based on less than 100 percent fines (RWQCB 1998).

6 RWQCB ambient benchmark is compared with the maximum site concentration for sample sizes less than or equal to 3 and for detection frequencies greater than 50 percent; otherwise, comparison is with the UCL_{95}.

ER-L Effects-range low
ER-M Effects-range median
FET Fisher's exact test
Max Maximum
mg/kg Milligram per kilogram
NA Not applicable; test not performed for this particular data set or sample pair
RWQCB California Regional Water Quality Control Board
UCL_{95} one-side 95 percent upper confidence limit on the arithmetic mean
WRS Wilcoxon rank sum
-- indicates comparison not made because no benchmark value exists

Source:

California Regional Water Quality Control Board. 1998. "Ambient Concentrations of Toxic Chemicals in San Francisco Bay Sediments." San Francisco Bay Region. April.

TABLE 56

SUMMARY FOR OTHER SEDIMENT PARAMETERS AT LITIGATION AREA LOCATIONS SAMPLED IN OCTOBER 2000
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Habitat	Parameter	Number of Locations	Concentration					
			Minimum	Median	Maximum	Mean	S.D.	Units
Ditches	Percent Solids	6	9.7	13.5	15.5	12.9	2.4	percent
	pH	3	7.0	7.7	7.8	7.4	0.4	pH
	Sulfide	3	1370	2300	5,270	2,980	2,037	mg/kg
	TOC by Lloyd Khan	24	19800	96900	194,000	94,888	45,591	mg/kg
Marsh Reference	TOC by Lloyd Khan	1	2660	2660	2,660	2,660	--	mg/kg
Marsh Surface	TOC by Lloyd Khan	12	41200	78600	154,000	84,542	38,318	mg/kg
Slough	Percent Solids	15	14.4	19.7	43.6	25.0	9.2	percent
	pH	8	7.0	7.9	8.0	7.6	0.4	pH
	Sulfide	8	306	1595	2,860	1,650	921	mg/kg
	TOC by Lloyd Khan	18	26100	48600	211,000	60,928	42,500	mg/kg
Slough Reference	Percent Solids	6	31.6	37.8	42.0	37.0	4.0	percent
	pH	3	8.1	8.3	8.4	8.3	0.2	pH
	Sulfide	3	1380	2,060	2,390	1,943	515	mg/kg
	TOC by Lloyd Khan	3	20800	23,600	39,100	27,833	9,857	mg/kg

Notes:

mg/kg Milligram per kilogram
pH Hydrogen ion concentration
S.D. Standard deviation of arithmetic mean
TOC Total organic carbon

TABLE 57

SUMMARY AND SCREEN OF TOTAL AND DISSOLVED INORGANIC CONCENTRATIONS IN SURFACE WATER SAMPLES COLLECTED ON TWO DATES IN OCTOBER 2000 AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

			Water Quality Benchmarks				TOTAL METALS				DISSOLVED METALS			
							Sampling Date				Sampling Date			
			Acute		Chronic		9 Oct 2000		23 Oct 2000		9 Oct 2000		23 Oct 2000	
Habitat	Sampling Location	Metal	Dissolved (µg/L)	Total (µg/L)	Dissolved (µg/L)	Total (µg/L)	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier
Ditches	R01DH092 (Unit 7)	Aluminum	NA	750.0	NA	87	**1,150.00**		**1,110.00**	J	17.20	UJ	14.30	UJ
		Antimony	---	---	---	---	1.45	U	1.45	U	1.45	U	1.45	U
		Arsenic	69	69	36	36	3.85	UJ	2.30	UJ	2.90	UJ	1.15	UJ
		Barium	---	---	---	---	143.00	J	135.00	J	134.00	J	130.00	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	2.90	UJ	1.65	UJ	0.65	UJ	0.80	UJ
		Iron	---	---	---	---	851.00	J	893.00	J	39.20	UJ	68.50	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.55	U
		Manganese	---	---	---	---	304.00		345.00		283.00		332.00	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	1.00	U	1.00	U	1.00	U	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	U	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	1.50	UJ	1.65	U	1.50	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	3.00	UJ	2.05	UJ	1.90	UJ	1.50	UJ
		Zinc	90	95.1	81	85.6	75.00	J	46.30		29.10	J	26.40	
	R01DH121 (Unit 7)	Aluminum	NA	750.0	NA	87	153.50	UJ	**1,540.00**	J	20.45	UJ	63.00	UJ
		Antimony	---	---	---	---	1.45	U	1.45	U	1.45	U	1.45	U
		Arsenic	69	69	36	36	2.80	UJ	2.50	UJ	1.10	U	2.70	UJ
		Barium	---	---	---	---	132.00	J	125.00	J	132.00	J	124.00	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	U	0.10	UJ
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	1.65	UJ	3.05	UJ	0.55	U	2.30	UJ
		Iron	---	---	---	---	31.05	UJ	1,260.00	J	28.25	UJ	280.00	J
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.65	U
		Manganese	---	---	---	---	225.00		325.00		224.00		302.00	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	1.00	U	1.00	U	2.40	J	1.90	UJ
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	U	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	3.30	J	1.65	U	1.50	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	1.25	U	4.20	UJ	1.25	U	1.25	U
		Zinc	90	95.1	81	85.6	75.90	J	66.30		52.90	J	**101.00**	

TABLE 57 (Continued)

SUMMARY AND SCREEN OF TOTAL AND DISSOLVED INORGANIC CONCENTRATIONS IN SURFACE WATER SAMPLES COLLECTED ON TWO DATES IN OCTOBER 2000 AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

			Water Quality Benchmarks				TOTAL METALS				DISSOLVED METALS			
							Sampling Date				Sampling Date			
			Acute		Chronic		9 Oct 2000		23 Oct 2000		9 Oct 2000		23 Oct 2000	
Habitat	Sampling Location	Metal	Dissolved (µg/L)	Total (µg/L)	Dissolved (µg/L)	Total (µg/L)	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier
Ditches (Continued)	R01DH265 [b] (Unit 7)	Aluminum	NA	750.0	NA	87	115.50	UJ	**1,010.00**		18.00	UJ	9.70	U
		Antimony	---	---	---	---	1.45	U	1.45	U	1.45	U	1.45	U
		Arsenic	69	69	36	36	16.40		3.85	UJ	4.10	UJ	1.80	UJ
		Barium	---	---	---	---	93.10	J	131.00	J	90.40	J	122.00	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.25	UJ	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.65	UJ	0.50	U	0.80	UJ	0.50	U
		Copper	4.8	5.8	3.1	3.7	5.15	UJ	2.80	UJ	**5.25**	UJ	1.30	J
		Iron	---	---	---	---	3,400.00	J	872.00		10.15	UJ	52.50	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.55	U	0.55	UJ	0.55	U
		Manganese	---	---	---	---	551.00		375.00		527.00		274.00	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	1.00	U	1.00	U	2.60	J	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	U	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	0.75	UJ	1.65	U	0.75	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	3.50	U	0.70	U	3.50	U	0.70	UJ
		Vanadium	---	---	---	---	1.55	UJ	4.90	UJ	1.25	U	2.45	UJ
		Zinc	90	95.1	81	85.6	81.40	J	68.40		52.10	J	36.10	
Slough	R01SH074 (Unit 10)	Aluminum	NA	750.0	NA	87	703.00		**2,280.00**	J	20.50	UJ	9.70	U
		Antimony	---	---	---	---	1.45	U	1.45	U	2.05	UJ	1.45	U
		Arsenic	69	69	36	36	1.10	U	1.10	U	2.25	UJ	2.10	UJ
		Barium	---	---	---	---	77.40	J	63.80	J	78.50	J	58.50	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	2.45	UJ	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	2.05	UJ	2.25	UJ	1.25	UJ	0.85	UJ
		Iron	---	---	---	---	410.00	J	1,940.00	J	10.15	UJ	30.10	J
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.65	U
		Manganese	---	---	---	---	73.40		57.30		65.20		23.60	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	2.50	J	1.00	U	4.00	J	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	U	0.65	UJ	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	0.75	UJ	1.65	U	3.00	J
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	3.00	UJ	5.65	UJ	2.80	J	2.05	UJ
		Zinc	90	95.1	81	85.6	22.00	J	6.50	UJ	14.00	J	1.55	UJ

TABLE 57 (Continued)

SUMMARY AND SCREEN OF TOTAL AND DISSOLVED INORGANIC CONCENTRATIONS IN SURFACE WATER SAMPLES COLLECTED ON TWO DATES IN OCTOBER 2000 AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

			Water Quality Benchmarks				TOTAL METALS				DISSOLVED METALS			
							Sampling Date				Sampling Date			
			Acute		Chronic		9 Oct 2000		23 Oct 2000		9 Oct 2000		23 Oct 2000	
Habitat	Sampling Location	Metal	Dissolved (µg/L)	Total (µg/L)	Dissolved (µg/L)	Total (µg/L)	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier
Slough (Continued)	R01SH097 (Unit 11)	Aluminum	NA	750.0	NA	87	751.00		**1,530.00**	J	9.70	U	14.60	UJ
		Antimony	---	---	---	---	1.45	U	1.45	U	1.45	U	1.45	U
		Arsenic	69	69	36	36	2.65	UJ	1.10	U	1.10	U	1.10	U
		Barium	---	---	---	---	115.00	J	89.10	J	112.00	J	83.60	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	1.85	UJ	0.55	U	3.05	UJ	0.55	U
		Iron	---	---	---	---	562.00	J	1,150.00	J	13.20	UJ	16.55	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.65	U
		Manganese	---	---	---	---	200.00		178.00		187.00		155.00	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	1.00	U	1.25	UJ	1.00	U	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	U	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	0.75	UJ	1.65	U	3.00	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	2.55	UJ	3.95	UJ	3.90	J	2.90	UJ
		Zinc	90	95.1	81	85.6	60.40	J	21.40		45.10	J	6.60	UJ
	R01SH118 (Unit 10)	Aluminum	NA	750.0	NA	87	242.00	UJ	**1,980.00**	J	30.95	UJ	13.70	UJ
		Antimony	---	---	---	---	1.65	UJ	1.45	U	1.70	UJ	1.45	U
		Arsenic	69	69	36	36	1.60	UJ	1.40	UJ	1.75	UJ	1.10	U
		Barium	---	---	---	---	86.80	J	62.70	J	83.40	J	62.50	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	1.40	UJ	2.40	UJ	**27.80**		0.85	UJ
		Iron	---	---	---	---	171.00	J	1,600.00	J	10.15	UJ	10.25	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.55	U
		Manganese	---	---	---	---	101.00		60.60		93.20		34.60	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	4.30	J	1.00	U	3.30	J	1.60	UJ
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	U	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	1.50	UJ	1.65	U	1.50	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	6.00	J	5.15	UJ	4.40	J	3.80	UJ
		Zinc	90	95.1	81	85.6	32.00	J	22.40		28.50	J	1.55	UJ

TABLE 57 (Continued)

SUMMARY AND SCREEN OF TOTAL AND DISSOLVED INORGANIC CONCENTRATIONS IN SURFACE WATER SAMPLES COLLECTED ON TWO DATES IN OCTOBER 2000 AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

			Water Quality Benchmarks				TOTAL METALS				DISSOLVED METALS			
							Sampling Date				Sampling Date			
			Acute		Chronic		9 Oct 2000		23 Oct 2000		9 Oct 2000		23 Oct 2000	
Habitat	Sampling Location	Metal	Dissolved (µg/L)	Total (µg/L)	Dissolved (µg/L)	Total (µg/L)	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier
Slough (Continued)	R01SH133 (Unit 10)	Aluminum	NA	750.0	NA	87	684.00		**2,120.00**	J	19.75	UJ	9.70	U
		Antimony	---	---	---	---	2.90	UJ	1.45	U	1.45	U	1.45	UJ
		Arsenic	69	69	36	36	2.65	UJ	3.25	UJ	2.15	UJ	1.10	U
		Barium	---	---	---	---	91.20	J	74.90	J	90.80	J	72.00	J
		Beryllium	---	---	---	---	0.15	UJ	0.15	U	0.15	UJ	0.15	UJ
		Cadmium	19.1	21.6	6.2	7.3	0.20	UJ	0.10	U	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.80	UJ	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.65	UJ	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	2.90	UJ	4.30	UJ	**25.40**		0.55	U
		Iron	---	---	---	---	421.00	J	1,780.00	J	10.15	UJ	10.15	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.65	U
		Manganese	---	---	---	---	111.00		114.00		103.00		87.20	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	5.60		1.35	UJ	2.70	J	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	UJ	1.30	UJ	0.50	UJ	0.50	UJ
		Selenium	290	290.6	4.6	5.0	1.65	U	0.75	UJ	1.65	U	2.70	J
		Silver	1.9	2.2	1.9	44	2.10		0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	UJ	0.70	UJ	3.50	U	2.20	J
		Vanadium	---	---	---	---	3.30	J	5.00	UJ	1.25	U	3.65	UJ
		Zinc	90	95.1	81	85.6	33.30	J	22.20		27.80	J	3.45	UJ
	R01SH244 (Unit 11)	Aluminum	NA	750.0	NA	87	211.50	UJ	**832.00**	J	33.95	UJ	9.70	U
		Antimony	---	---	---	---	1.45	U	1.45	UJ	1.45	U	1.45	UJ
		Arsenic	69	69	36	36	2.65	UJ	2.30	UJ	2.45	UJ	2.20	UJ
		Barium	---	---	---	---	163.00	J	140.00	J	162.00	J	136.00	J
		Beryllium	---	---	---	---	0.15	U	0.15	UJ	0.15	U	0.15	UJ
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	UJ	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	1.00	UJ	2.25	UJ	**7.40**	UJ	0.70	UJ
		Iron	---	---	---	---	226.00	J	632.00	J	23.10	UJ	39.35	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.55	UJ
		Manganese	---	---	---	---	558.00		465.00		551.00		452.00	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	1.00	U	1.35	UJ	1.00	U	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	UJ	0.50	U	0.50	UJ
		Selenium	290	290.6	4.6	5.0	1.65	U	1.50	UJ	1.65	U	1.50	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	UJ	0.85	U	0.85	U
		Thallium	---	---	---	---	3.50	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	1.95	UJ	6.90	UJ	4.10	J	1.25	U
		Zinc	90	95.1	81	85.6	78.70	J	65.00		53.40	J	30.90	

TABLE 57 (Continued)

SUMMARY AND SCREEN OF TOTAL AND DISSOLVED INORGANIC CONCENTRATIONS IN SURFACE WATER SAMPLES COLLECTED ON TWO DATES IN OCTOBER 2000 AT THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

			Water Quality Benchmarks				TOTAL METALS				DISSOLVED METALS			
							Sampling Date				Sampling Date			
			Acute		Chronic		9 Oct 2000		23 Oct 2000		9 Oct 2000		23 Oct 2000	
Habitat	Sampling Location	Metal	Dissolved (µg/L)	Total (µg/L)	Dissolved (µg/L)	Total (µg/L)	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier	Concentration (µg/L)[a]	Data Qualifier
Slough (Continued)	R01SH251 (Unit 11)	Aluminum	NA	750.0	NA	87	210.50	UJ	**807.00**	J	28.20	UJ	25.15	UJ
		Antimony	---	---	---	---	1.45	U	1.45	U	2.70	UJ	1.45	U
		Arsenic	69	69	36	36	2.35	UJ	2.85	UJ	1.30	UJ	1.10	U
		Barium	---	---	---	---	152.00	J	131.00	J	144.00	J	129.00	J
		Beryllium	---	---	---	---	0.15	U	0.15	U	0.15	U	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	U	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	1.15	UJ	1.85	UJ	**24.50**		0.55	U
		Iron	---	---	---	---	190.00	J	528.00	J	13.95	UJ	75.50	UJ
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.65	U
		Manganese	---	---	---	---	383.00		343.00		357.00		336.00	
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	1.00	U	1.00	U	1.00	U	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	U	0.50	U	0.50	U	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	1.50	UJ	1.65	U	1.50	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	U	0.70	UJ	0.70	U	0.70	UJ
		Vanadium	---	---	---	---	1.50	UJ	2.85	UJ	4.40	J	1.25	UJ
		Zinc	90	95.1	81	85.6	77.40	J	56.80		49.90	J	36.00	
Slough Reference	SLRSH001	Aluminum	NA	750.0	NA	87	**1,720.00**		**1,900.00**		31.35	UJ	13.20	UJ
		Antimony	---	---	---	---	1.45	U	1.45	U	1.45	U	1.45	U
		Arsenic	69	69	36	36	1.10	U	2.90	UJ	2.00	UJ	2.10	UJ
		Barium	---	---	---	---	64.30	J	61.90	J	59.00	J	57.90	J
		Beryllium	---	---	---	---	0.15	UJ	0.15	U	0.15	UJ	0.15	U
		Cadmium	19.1	21.6	6.2	7.3	0.10	U	0.10	U	0.10	UJ	0.10	U
		Chromium	1,707.9	5,404.6	230.7	268.2	0.55	U	0.55	U	0.55	U	0.55	U
		Cobalt	---	---	---	---	0.50	U	0.50	U	0.50	U	0.50	U
		Copper	4.8	5.8	3.1	3.7	2.40	UJ	3.15	UJ	2.35	UJ	1.30	J
		Iron	---	---	---	---	1,360.00	J	1,620.00		10.15	UJ	10.15	U
		Lead	210	220.8	8.1	8.5	0.55	UJ	0.65	U	0.55	UJ	0.65	U
		Manganese	---	---	---	---	28.90		50.10		0.75	UJ	4.05	UJ
		Mercury	1.40	1.6	0.025	0.025	0.05	U	0.05	U	0.05	U	0.05	U
		Molybdenum	---	---	---	---	3.40	J	1.00	U	3.40	J	1.00	U
		Nickel	74	74.7	8.2	8.3	0.50	UJ	0.50	U	0.50	UJ	0.50	U
		Selenium	290	290.6	4.6	5.0	1.65	U	0.75	UJ	1.65	U	0.75	UJ
		Silver	1.9	2.2	1.9	44	0.85	U	0.85	U	0.85	U	0.85	U
		Thallium	---	---	---	---	0.70	UJ	0.70	U	0.70	UJ	0.70	U
		Vanadium	---	---	---	---	3.45	UJ	6.15	UJ	1.25	U	3.25	UJ
		Zinc	90	95.1	81	85.6	3.45	UJ	6.75	UJ	4.90	UJ	3.30	UJ

TABLE 57 (Continued)

SUMMARY AND SCREEN OF TOTAL AND DISSOLVED INORGANIC CONCENTRATIONS IN SURFACE WATER SAMPLES COLLECTED ON TWO DATES IN OCTOBER 2000 AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:	Acute and chronic criteria listed for chromium are for chromium (III)
	Shaded cells indicate exceedance of chronic criteria
	Bolded text indicate exceedance of acute criteria
a	Concentration is one-half the validated result for nondetected samples
b	No water at R01DH265 on 10/23/00, sample collected at R01DH299
c	Not available
J	Estimated value
µg/L	Microgram per liter
U	Not detected
---	Not applicable; no criteria are available

TABLE 58

DATA SUMMARY FOR TOTAL DDTs, PCBs, AND AROCLORS BY HABITAT AREA
DETECTED AND NONDETECTED DATA INCLUDED
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte Group	Analyte	Habitat	Number of Locations Sampled	Number of Locations with at Least One Detected Congener[1]	Concentrations Calculated Using Two Options for Treating Nondetected Data (units in µg/kg)						Sedim Benchm	
					One-half DL Used for Nondetects			Full DL used for Nondetects				
					Min	Max	Median	Min	Max	Median	ER-L	E
LPEST	Total DDTs	Marsh Reference	1	0	0.39	0.39	0.39	0.78	0.78	0.78	1.58	
		Upland Reference	4	4	0.66	3.94	3.07	0.86	3.99	3.12	1.58	
	Total PCBs	Marsh Reference	1	1	1.61	1.61	1.61	2.86	2.86	2.86	22.7	
		Upland Reference	4	3	0.90	2.50	1.98	1.80	2.95	2.48	22.7	
PEST	Total Aroclors	Ditches	23	0	600.00	1,120.00	840.00	1,200.00	2,240.00	1,680.00	--	
		Marsh Reference	4	0	164.50	485.00	339.50	329.00	970.00	679.00	--	
		Marsh Surface	22	0	137.00	880.00	485.00	274.00	1,760.00	970.00	--	
		RASS 3 and 4 Upland	16	4	136.00	1,630.00	140.25	272.00	1,760.00	280.50	--	
		RASS 3 Pond	5	0	237.00	351.00	277.00	474.00	702.00	554.00	--	
		RASS 4 Wetland	6	0	165.00	445.00	357.00	330.00	890.00	714.00	--	
		Slough	26	0	314.00	960.00	405.00	628.00	1,920.00	810.00	--	
		Upland Reference	1	0	144.00	144.00	144.00	288.00	288.00	288.00	--	
	Total DDTs	Ditches	23	0	22.50	42.00	31.50	45.00	84.00	63.00	1.58	
		Marsh Reference	4	0	6.15	18.00	12.30	12.30	36.00	24.60	1.58	
		Marsh Surface	22	6	5.25	33.40	18.90	8.70	66.00	36.00	1.58	
		RASS 3 and 4 Upland	16	5	5.10	40.40	5.40	10.20	40.40	10.80	1.58	
		RASS 3 Pond	5	1	8.85	14.30	10.35	17.70	26.10	20.70	1.58	
		RASS 4 Wetland	6	5	7.30	329.00	14.40	11.40	329.00	23.65	1.58	
		Slough	26	2	11.70	36.00	15.00	23.40	72.00	30.00	1.58	
		Upland Reference	1	0	5.40	5.40	5.40	10.80	10.80	10.80	1.58	

Notes: Total DDTs for LPEST is the sum of the 2,4' and 4,4' congeners of DDD, DDE, and DDT

Total DDTs for PEST is the sum of the 4,4' congeners of DDD, DDE, and DDT

Total PCBs is the sum of 18 congeners multiplied by 2.0 (NOAA 1993)

Total aroclors is the sum of seven congeners

1 Summaries are based on the depth and sample at each location that contained the highest concentration for each analyte.

Number of of detects is the total number of locations where at least one congener was detected; the number of detects was determined after selecting the depth that contained the highest possible analyte concentration, therefore, this number may differ from a detection frequency calculated using all depths and samples

DDD Dichlorodiphenyldichloroethane

DDE Dichlorodiphenyldichloroethene

DDT Dichlorodiphenyltrichloroethane

DL Detection limit

ER-L Effects range-low

ER-M Effects range-median

LPEST Modified low-level CLP pesticide methods

max Maximum total concentration for a location

min Minimum total concentration for a location

PEST CLP (non low-level) pesticide methods

Source: National Oceanic and Atmospheric Administration (NOAA). 1993. "Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects. 1984-1992." Volumes I thr NOAA Technical Memorandum, NOS ORCA 71. July.

TABLE 59

DATA SUMMARY FOR TOTAL DDTs, PCBs, AND AROCLORS BY HABITAT AREA
DETECTED DATA ONLY
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte Group	Analyte	Habitat	Number of Locations	Number of Locations with at Least One Detected Congener	Number of Samples with at Least One Detected Congener	Concentration in µg/kg (Zero Substituted for NDs)			Sediment Benchmarks	
						Min	Max	Median	ER-L	ER-M
LPEST	Total DDTs	Upland Reference	4	4	7	0.28	3.89	0.46	1.58	46.1
	Total PCBs	Marsh Reference	1	1	1	0.36	0.36	0.36	22.7	180
		Upland Reference	4	3	5	0.24	2.05	0.92	22.7	180
PEST	Total DDTs	Ditches	23	0	0	--	--	--	1.58	46.1
		Marsh Reference	4	2	2	6.30	15.70	11.00	1.58	46.1
		Marsh Surface	22	9	9	1.90	33.40	11.00	1.58	46.1
		RASS 3 and 4 Upland	16	5	7	4.70	40.40	11.00	1.58	46.1
		RASS 3 Pond	5	1	2	5.30	6.60	5.95	1.58	46.1
		RASS 4 Wetland	6	6	7	3.20	329.00	7.70	1.58	46.1
		Slough	26	3	5	3.70	11.00	5.60	1.58	46.1
		Upland Reference	1	0	0	--	--	--	1.58	46.1
	Total Aroclors	Ditches	23	0	0	--	--	--	--	--
		Marsh Reference	4	0	0	--	--	--	--	--
		Marsh Surface	22	0	0	--	--	--	--	--
		RASS 3 and 4 Upland	16	4	6	48.00	1,500.00	275.00	--	--
		RASS 3 Pond	5	0	0	--	--	--	--	--
		RASS 4 Wetland	6	1	1	45.00	45.00	45.00	--	--
		Slough	26	1	1	210.00	210.00	210.00	--	--
		Upland Reference	1	0	0	--	--	--	--	--

Notes: Summaries were prepared using all surface (0-0.5 ft bgs) and subsurface (0.5-1.5 ft bgs) samples
Zero was substituted for all non-detected congeners in the calculation of totals
Total DDTs for LPEST is the sum of the 2,4' and 4,4' congeners for DDD, DDE, and DDT
Total DDTs for PEST is the sum of the 4,4' congeners for DDD, DDE, and DDT
Toal PCBs is the sum of 18 congeners multiplied by two
Total aroclors is the sum of seven congeners

bgs Below ground surface
CLP Contract laboratory program
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ft Feet
LPEST Modified low-level CLP pesticide methods
ND Non-detected sample - sample concentration below the detection limit
min Minimum total concentration for a location
max Maximum total concentration for a location
PEST CLP (non low-level) pesticide methods

TABLE 60

CONCENTRATIONS OF TOTAL DDTs AND PCBs BY HABITAT AREA AND LOCATION
CALCULATED USING TWO OPTIONS FOR TREATING NONDETECTED DATA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte Group	Analyte	Habitat	Location	Sample	Depth	Totals Calculated using Two Methods (µg/kg)	
						One-half DL for NDs	Full DL for NDs
LPEST	DDT	Marsh Reference	MHRSS001	295MHRSC196	Surface	0.39	0.78
		Upland Reference	UDRSS001	295UDRSC121	Surface	0.66	0.86
			UDRSS003	295UDRSC119	Surface	3.65	3.70
			UDRSS005	295UDRSC117	Surface	3.94	3.99
			UDRSS007	295UDRSC115	Surface	2.48	2.53
	PCB	Marsh Reference	MHRSS001	295MHRSC196	Surface	1.61	2.86
		Upland Reference	UDRSS001	295UDRSB122	Subsurface	0.90	1.80
			UDRSS003	295UDRSC119	Surface	2.50	2.95
			UDRSS005	295UDRSC117	Surface	2.49	2.94
			UDRSS007	295UDRSC115	Surface	1.47	2.02
PEST	DDT	Ditches	R01DH009	295R01SC029	Surface	31.50	63.00
			R01DH018	295R01SB028	Subsurface	31.50	63.00
			R01DH019	295R01SB061	Subsurface	33.00	66.00
			R01DH020	295R01SB009	Subsurface	31.50	63.00
			R01DH021	295R01SB007	Subsurface	31.50	63.00
			R01DH026	295R01SB064	Subsurface	31.50	63.00
			R01DH027	295R01SB109	Subsurface	34.50	69.00
			R01DH030	295R01SC058	Surface	33.00	66.00
			R01DH035	295R01SB023	Subsurf	28.50	57.00
			R01DH040	295R01SB021	Subsurface	27.00	54.00
			R01DH049	295R01SB011	Subsurface	33.00	66.00
			R01DH056	295R01SC017	Surface	28.50	57.00
			R01DH057	295R01SC128	Surface	33.00	66.00
			R01DH066	295R01SB016	Subsurface	31.50	63.00
			R01DH067	295R01SC148	Surface	27.00	54.00
			R01DH073	295R01SC129	Surface	42.00	84.00
			R01DH086	295R01SC001	Surface	42.00	84.00
			R01DH087	295R01SB004	Subsurface	30.00	60.00
			R01DH096	295R01SB025	Subsurface	36.00	72.00
			R01DH099	295R01SC150	Surface	22.50	45.00
			R01DH100	295R01SC147	Surface	27.00	54.00
			R01DH117	295R01SC097	Surface	34.50	69.00
			R01DH124	295R01SB101	Subsurface	24.00	48.00
		Marsh Reference	MHRSS002	295MHRSC199	Surface	6.15	12.30
			MHRSS003	295MHRSB202	Subsurface	18.00	36.00
			MHRSS004	295MHRSB171	Subsurface	10.20	20.40
			MHRSS005	295MHRSC203	Surface	14.40	28.80
		Marsh Surface	R01SS009	295R01SC172	Surface	16.50	33.00
			R01SS010	295R01SC142	Surface	21.00	42.00
			R01SS011	295R01SC141	Surface	15.40	23.80
			R01SS016	295R01SC105	Surface	19.50	39.00
			R01SS017	295R01SB107	Subsurface	16.50	33.00
			R01SS024	295R01SC188	Surface	8.85	17.70
			R01SS044	295R01SC189	Surface	14.40	28.80

TABLE 60 (Continued)

CONCENTRATIONS OF TOTAL DDTs AND PCBs BY HABITAT AREA AND LOCATION
CALCULATED USING TWO OPTIONS FOR TREATING NONDETECTED DATA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte Group	Analyte	Habitat	Location	Sample	Depth	Totals Calculated using Two Methods (µg/kg)	
						One-half DL for NDs	Full DL for NDs
PEST	DDT	Marsh Surface	R01SS045	295R01SC184	Surface	29.00	45.00
			R01SS071	295R01SC165	Surface	18.30	30.30
			R01SS072	295R01SC130	Surface	33.00	66.00
			R01SS076	295R01SC144	Surface	24.00	48.00
			R01SS078	295R01SB136	Subsurface	27.00	54.00
			R01SS084	295R01SC112	Surface	22.50	45.00
			R01SS088	295R01SC145	Surface	27.00	43.00
			R01SS091	295R01SC143	Surface	18.00	36.00
			R01SS095	295R01SC093	Surface	25.50	51.00
			R01SS103	295R01SC102	Surface	12.15	24.30
			R01SS104	295R01SB158	Subsurface	18.00	36.00
			R01SS108	295R01SC139	Surface	21.00	42.00
			R01SS138	295R01SC138	Surface	33.40	33.40
			R01SS143	295R01SC137	Surface	5.25	10.50
			R02SS151	295R02SC087	Surface	5.30	8.70
		RASS 3 and 4 Upland	R03SS167	295R03SC194	Surface	5.10	10.20
			R03SS168	295R03SC089	Surface	5.10	10.20
			R03SS169	295R03SC192	Surface	11.60	18.50
			R03SS171	295R03SC090	Surface	5.10	10.20
			R03SS173	295R03SC187	Surface	5.10	10.20
			R03SS174	295R03SB186	Subsurface	5.55	11.10
			R03SS175	295R03SS083	Surface	5.10	10.20
			R03SS176	295R03SS082	Surface	40.40	40.40
			R03SS177	295R03SC091	Surface	5.10	10.20
			R03SS178	295R03SS084	Surface	5.25	10.50
			R03SS179	295R03SS085	Surface	10.05	20.10
			R03SS182	295R03SC088	Surface	5.25	10.50
			R03SS214	080R03SC309	Surface	10.95	12.80
			R03SS215	080R03SC310	Surface	7.65	15.30
			R03SS216	080R03SC311	Surface	20.55	22.40
			R04SS198	295R04SC195	Surface	33.75	35.50
		RASS 3 Pond	R03WD153	295R03SB075	Subsurface	8.85	17.70
			R03WD154	295R03SC071	Surface	10.35	20.70
			R03WD155	295R03SB054	Subsurface	14.30	22.00
			R03WD156	295R03SB078	Subsurface	13.05	26.10
			R03WD157	295R03SC055	Surface	10.05	20.10
		RASS 4 Wetland	R04WD199	295R04SC066	Surface	13.50	27.00
			R04WD203	295R04SB069	Subsurface	13.50	22.30
			R04WD204	295R04SB080	Subsurface	18.05	21.20
			R04WD211	080R04SB321	Subsurface	7.30	11.40
			R04WD212	080R04SB317	Subsurface	329.00	329.00
			R04WD213	080R04SB320	Subsurface	15.30	25.00
		Slough	R01SH015	295R01SC031	Surface	12.75	25.50
			R01SH023	295R01SB176	Subsurface	22.00	33.00
			R01SH028	295R01SB208	Subsurface	12.15	24.30
			R01SH029	295R01SC125	Surface	11.70	23.40

TABLE 60 (Continued)

CONCENTRATIONS OF TOTAL DDTs AND PCBs BY HABITAT AREA AND LOCATION
CALCULATED USING TWO OPTIONS FOR TREATING NONDETECTED DATA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte Group	Analyte	Habitat	Location	Sample	Depth	Totals Calculated using Two Methods (µg/kg)	
						One-half DL for NDs	Full DL for NDs
PEST	DDT	Slough	R01SH033	295R01SC209	Surface	13.20	26.40
			R01SH038	295R01SB047	Subsurface	36.00	72.00
			R01SH043	295R01SB178	Subsurface	24.00	48.00
			R01SH046	295R01SC039	Surface	12.30	24.60
			R01SH048	295R01SB037	Subsurface	14.25	28.50
			R01SH050	080R01SB314	Subsurface	18.00	36.00
			R01SH055	295R01SC013	Surface	19.50	39.00
			R01SH058	295R01SC041	Surface	15.00	30.00
			R01SH065	295R01SB035	Subsurface	16.50	33.00
			R01SH074	295R01SC180	Surface	19.10	30.10
			R01SH075	295R01SC043	Surface	15.00	30.00
			R01SH077	295R01SC151	Surface	13.05	26.10
			R01SH081	295R01SC132	Surface	19.50	39.00
			R01SH082	295R01SC161	Surface	21.00	42.00
			R01SH097	295R01SB164	Subsurface	16.50	33.00
			R01SH111	295R01SC050	Surface	15.00	30.00
			R01SH118	295R01SC153	Surface	16.50	33.00
			R01SH130	295R01SC048	Surface	11.85	23.70
			R01SH131	295R01SB156	Subsurface	13.65	27.30
			R01SH134	295R01SC095	Surface	14.40	28.80
			R01SH217	080R01SB312	Subsurface	14.10	28.20
			R01SH218	080R01SB315	Subsurface	22.50	45.00
		Upland Reference	UDRSS004	295UDRSB169	Subsurface	5.40	10.80

Notes: The higher of the surface or subsurface samples at each location was used in analysis.
Total DDTs for LPEST is the sum of the 2,4' and 4,4' congeners of DDD, DDE, and DDT
Total DDTs for PEST is the sum of the 4,4' congeners of DDD, DDE, and DDT
Total PCBs is the sum of 18 congeners multiplied by 2.0 (NOAA 1993).

bgs Below ground surface
CLP Contract laboratory program
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
Depth Surf is a surface sample (0 to 0.5 ft bgs), subsurf is a subsurface sample (0.5 to 1.5 ft bgs)
DL Detection limit
ft Feet
LPEST Modified low-level CLP pesticide methods
ND Nondetected sample - sample concentration below the detection limit
PEST CLP (non low-level) pesticide methods

Source:

National Oceanic and Atmospheric Administration (NOAA). 1993. "Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects. 1984-1992." Volumes I through IV. NOAA Technical Memorandum, NOS ORCA 71. July.

TABLE 61

SUMMARY OF DETECTION LIMITS FOR ANALYSIS OF DDTs AND PCBs, AND AROCLORS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte Group	Analyte	Congener/Group	Number of Samples	Minimum DL (µg/kg)	Median DL (µg/kg)	Maximum DL (µg/kg)
LPEST	DDT	2,4'-DDD	10	0.10	0.13	0.47
		2,4'-DDE	10	0.10	0.10	0.13
		2,4'-DDT	10	0.10	0.12	0.34
		4,4'-DDD	10	0.10	0.11	0.26
		4,4'-DDE	10	0.10	0.29	0.97
		4,4'-DDT	10	0.10	0.13	2.20
	PCB	PCB-101 (2,2',3,5,5')	9	0.10	0.12	0.57
		PCB-105 (2,3,3',4,4')	10	0.10	0.11	0.19
		PCB-118 (2,3',4,4',5)	9	0.10	0.11	0.20
		PCB-128 (2,2',3,3',4,4')	10	0.10	0.10	0.36
		PCB-138 (2,2',3,4,4',5')	10	0.10	0.12	0.26
		PCB-153 (2,2',4,4',5,5')	10	0.10	0.12	0.25
		PCB-170 (2,2',3,3',4,4',5)	10	0.10	0.10	0.19
		PCB-18 (2,2',5)	10	0.10	0.11	0.14
		PCB-180 (2,2',3,4,4',5,5')	10	0.10	0.12	0.19
		PCB-187 (2,2',3,4',5,5',6)	8	0.10	0.10	0.13
		PCB-195 (2,2',3,3',4,4',5,6)	10	0.10	0.10	0.13
		PCB-206 (2,2,',3,3',4,4',5,5',	10	0.10	0.10	0.13
		PCB-209 (2,2',3,3',4,4',5,5',6	10	0.10	0.10	0.13
		PCB-28 (2,4,4')	10	0.10	0.12	0.42
		PCB-44 (2,2',3,5')	10	0.10	0.10	0.13
		PCB-52 (2,2',5,5')	10	0.10	0.10	0.13
		PCB-66 (2,3',4,4')	9	0.10	0.10	0.13
		PCB-8 (2,4')	10	0.10	0.10	0.65
PEST	DDT	4,4'-DDD	168	2.20	9.60	280.00
		4,4'-DDE	168	2.60	9.05	28.00
		4,4'-DDT	168	0.62	10.00	35.00
	AROCLOR	AROCLOR-1016	168	34.00	96.00	280.00
		AROCLOR-1221	168	68.00	200.00	560.00
		AROCLOR-1232	168	34.00	96.00	280.00
		AROCLOR-1242	166	34.00	96.50	280.00
		AROCLOR-1248	163	34.00	100.00	280.00
		AROCLOR-1254	168	34.00	96.00	280.00
		AROCLOR-1260	167	34.00	96.00	280.00

Notes:

CLP Contract laboratory program

DL Detection limit

DDD Dichlordiphenyldrichlorethane

DDE Dichlordiphenyldichloroethene

DDT Dichlorodiphenyltrichloroethane

LPEST Modified low-level CLP pesticide methods

µg/kg Microgram per kilogram

PEST CLP (non low-level) pesticide methods

PCB Polychlorinated biphenyl

TABLE 62

CONCENTRATIONS OF TOTAL AROCLORS BY HABITAT AREA AND LOCATION CALCULATED USING TWO OPTIONS FOR TREATING NONDETECTED DATA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Habitat	Location	Sample	Depth	Totals Calculated using Two Methods (units in µg/kg)	
				One-half DL for NDs	Full DL for NDs
Ditches	R01DH009	295R01SC029	Surface	840.00	1,680.00
	R01DH018	295R01SB028	Subsurface	840.00	1,680.00
	R01DH019	295R01SB061	Subsurface	885.00	1,770.00
	R01DH020	295R01SB009	Subsurface	840.00	1,680.00
	R01DH021	295R01SB007	Subsurface	840.00	1,680.00
	R01DH026	295R01SB064	Subsurface	840.00	1,680.00
	R01DH027	295R01SB109	Subsurface	930.00	1,860.00
	R01DH030	295R01SC058	Surface	885.00	1,770.00
	R01DH035	295R01SB023	Subsurface	755.00	1,510.00
	R01DH040	295R01SB021	Subsurface	715.00	1,430.00
	R01DH049	295R01SB011	Subsurface	880.00	1,760.00
	R01DH056	295R01SC017	Surface	755.00	1,510.00
	R01DH057	295R01SC128	Surface	880.00	1,760.00
	R01DH066	295R01SB016	Subsurface	840.00	1,680.00
	R01DH067	295R01SC148	Surface	725.00	1,450.00
	R01DH073	295R01SC129	Surface	1,120.00	2,240.00
	R01DH086	295R01SC001	Surface	1,120.00	2,240.00
	R01DH087	295R01SB004	Subsurface	795.00	1,590.00
	R01DH096	295R01SB025	Subsurface	960.00	1,920.00
	R01DH099	295R01SC150	Surface	600.00	1,200.00
	R01DH100	295R01SC147	Surface	725.00	1,450.00
	R01DH117	295R01SC097	Surface	925.00	1,850.00
	R01DH124	295R01SB101	Subsurface	650.00	1,300.00
Marsh Reference	MHRSS002	295MHRSC199	Surface	164.50	329.00
	MHRSS003	295MHRSB202	Subsurface	485.00	970.00
	MHRSS004	295MHRSB171	Subsurface	274.00	548.00
	MHRSS005	295MHRSB204	Subsurface	405.00	810.00
Marsh Surface	R01SS009	295R01SC172	Surface	445.00	890.00
	R01SS010	295R01SC142	Surface	560.00	1,120.00
	R01SS011	295R01SC141	Surface	337.00	674.00
	R01SS016	295R01SC105	Surface	525.00	1,050.00
	R01SS017	295R01SC106	Surface	475.00	950.00
	R01SS024	295R01SC188	Surface	237.00	474.00
	R01SS044	295R01SC189	Surface	388.00	776.00
	R01SS045	295R01SC184	Surface	640.00	1,280.00
	R01SS071	295R01SC165	Surface	485.00	970.00
	R01SS072	295R01SC130	Surface	880.00	1,760.00
	R01SS076	295R01SC144	Surface	645.00	1,290.00
	R01SS078	295R01SB136	Subsurface	725.00	1,450.00
	R01SS084	295R01SC112	Surface	600.00	1,200.00
	R01SS088	295R01SC145	Surface	645.00	1,290.00
	R01SS091	295R01SC143	Surface	480.00	960.00
	R01SS095	295R01SC093	Surface	685.00	1,370.00
	R01SS103	295R01SC102	Surface	323.00	646.00
	R01SS104	295R01SC157	Surface	485.00	970.00
	R01SS108	295R01SC139	Surface	565.00	1,130.00

TABLE 62 (Continued)

CONCENTRATIONS OF TOTAL AROCLORS BY HABITAT AREA AND LOCATION CALCULATED USING TWO OPTIONS FOR TREATING NONDETECTED DATA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Habitat	Location	Sample	Depth	Totals Calculated using Two Methods (units in µg/kg)	
				One-half DL for NDs	Full DL for NDs
Marsh Surface	R01SS138	295R01SC138	Surface	148.50	297.00
	R01SS143	295R01SC137	Surface	140.50	281.00
	R02SS151	295R02SC087	Surface	137.00	274.00
RASS 3 and 4 Upland	R03SS167	295R03SC194	Surface	136.50	273.00
	R03SS168	295R03SC089	Surface	136.00	272.00
	R03SS169	295R03SC192	Surface	722.50	965.00
	R03SS171	295R03SC090	Surface	136.50	273.00
	R03SS173	295R03SC187	Surface	136.50	273.00
	R03SS174	295R03SB186	Subsurface	148.00	296.00
	R03SS175	295R03SS083	Surface	136.50	273.00
	R03SS176	295R03SS082	Surface	136.00	272.00
	R03SS177	295R03SC091	Surface	136.00	272.00
	R03SS178	295R03SS084	Surface	140.50	281.00
	R03SS179	295R03SS085	Surface	271.00	542.00
	R03SS182	295R03SC088	Surface	141.00	282.00
	R03SS214	080R03SC309	Surface	1,630.00	1,760.00
	R03SS215	080R03SC310	Surface	204.00	338.00
	R03SS216	080R03SC311	Surface	750.00	880.00
	R04SS198	295R04SC195	Surface	140.00	280.00
RASS 3 Pond	R03WD153	295R03SB075	Subsurface	237.00	474.00
	R03WD154	295R03SC071	Surface	277.00	554.00
	R03WD155	295R03SB054	Subsurface	311.00	622.00
	R03WD156	295R03SB078	Subsurface	351.00	702.00
	R03WD157	295R03SC055	Surface	271.00	542.00
RASS 4 Wetland	R04WD199	295R04SC066	Surface	360.00	720.00
	R04WD203	295R04SB069	Subsurface	354.00	708.00
	R04WD204	295R04SC079	Surface	263.00	526.00
	R04WD211	080R04SB321	Subsurface	165.00	330.00
	R04WD212	080R04SB317	Subsurface	445.00	890.00
	R04WD213	080R04SB320	Subsurface	391.00	782.00
Slough	R01SH015	295R01SC031	Surface	340.00	680.00
	R01SH023	295R01SB176	Subsurface	435.00	870.00
	R01SH028	295R01SB208	Subsurface	323.00	646.00
	R01SH029	295R01SC125	Surface	314.00	628.00
	R01SH033	295R01SC209	Surface	354.00	708.00
	R01SH038	295R01SB047	Subsurface	960.00	1,920.00
	R01SH043	295R01SB178	Subsurface	640.00	1,280.00
	R01SH046	295R01SC039	Surface	331.00	662.00
	R01SH048	295R01SB037	Subsurface	380.00	760.00
	R01SH050	080R01SB314	Subsurface	480.00	960.00
	R01SH055	295R01SC013	Surface	520.00	1,040.00
	R01SH058	295R01SC041	Surface	400.00	800.00
	R01SH065	295R01SB035	Subsurface	440.00	880.00
	R01SH074	295R01SC180	Surface	445.00	890.00
	R01SH075	295R01SC043	Surface	405.00	810.00
	R01SH077	295R01SC151	Surface	351.00	702.00

TABLE 62 (Continued)

CONCENTRATIONS OF TOTAL AROCLORS BY HABITAT AREA AND LOCATION CALCULATED USING TWO OPTIONS FOR TREATING NONDETECTED DATA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Habitat	Location	Sample	Depth	Totals Calculated using Two Methods (units in µg/kg)	
				One-half DL for NDs	Full DL for NDs
Slough	R01SH081	295R01SC132	Surface	525.00	1,050.00
	R01SH082	295R01SC161	Surface	560.00	1,120.00
	R01SH097	295R01SB164	Subsurface	435.00	870.00
	R01SH111	295R01SC050	Surface	405.00	810.00
	R01SH118	295R01SC153	Surface	445.00	890.00
	R01SH130	295R01SC048	Surface	317.00	634.00
	R01SH131	295R01SB156	Subsurface	368.00	736.00
	R01SH134	295R01SC095	Surface	388.00	776.00
	R01SH217	080R01SB312	Subsurface	377.00	754.00
	R01SH218	080R01SB315	Subsurface	600.00	1,200.00
Upland Reference	UDRSS004	295UDRSB169	Subsurface	144.00	288.00

Notes: The higher of the surface or subsurface samples at each location was used in analysis.
CLP (non low-level) pesticide methods used

bgs Below ground surface
CLP Contract laboratory program
Depth Surf is a surface sample (0 to 0.5 ft bgs), subsurf is a subsurface sample (0.5 to 1.5 ft bgs)
DL Detection limit
ft Feet
µg/kg Microgram per kilogram
ND Nondetected sample - sample concentration below the detection limit

TABLE 63

SUMMARY STATISTICS FOR METALS IN SEDIMENT AND SOIL COLLECTED FROM THE LITIGATION AREA DURING MONITORING YEARS ONE THROUGH FIVE AND USED TO DEFINE HOTSPOT CONCENTRATIONS BASED ON SEVEN METALS AND THE MEAN ER-M QUOTIENT
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Number of Samples	Minimum mg/kg	Median mg/kg	Maximum mg/kg	Mean mg/kg	S.D. mg/kg	UCL_{95} mg/kg	Percentiles 25th mg/kg	Percentiles 75th mg/kg	Hotspot Threshold mg/kg
Arsenic	1,076	0.10	22.35	3,260.00	82.04	206.43	92.40	11.82	61.18	135.22
Cadmium	1,074	0.00	1.10	832.00	5.07	29.19	6.54	0.11	3.40	8.34
Copper	1,076	0.07	75.80	1,560.00	129.96	186.02	139.30	43.58	129.00	257.13
Lead	1,076	0.23	42.55	6,060.00	94.75	312.27	110.42	29.10	79.70	155.60
Mercury	140	0.01	0.18	143.00	2.55	13.25	4.41	0.05	0.46	1.08
Selenium	1,076	0.00	1.05	657.00	3.14	25.44	4.41	0.41	2.40	5.39
Zinc	1,076	0.13	360.00	89,300.00	1,075.64	3,381.47	1,245.34	165.25	1,017.50	2,295.88
Mean $ER\text{-}M_q$	1,076	0.03	0.59	72.33	1.27	3.67	1.46	0.29	1.20	2.57

Notes: The hotspot threshold concentrations are defined as metal concentrations that exceeded 1.5 times the interquartile range for the distribution of conentrations using data for each sampling year and each location. The interquartile range is defined as the difference between the 75th and 25th percentile of the distribution.
Number of samples is the total number of samples from all locations and sampling rounds.

ER-Mq Mean effects-range median quotient for 7 metals; values for the mean ER-Mq are unitlesss.
Minimum Minimum concentration reported
Maximum Maximum concentration reported
S.D. Standard deviation of the arithmetic mean
UCL_{95} One-sided 95 percent confidence of the arithmetic mean calculated assuming a normal distribution

TABLE 64

NUMBER OF SEDIMENT AND SOIL LOCATIONS WITHIN INDIVIDUAL HABITATS IDENTIFIED AS HOTSPOTS BASED ON COMPARISON TO SEVEN METALS AND THE MEAN ER-M QUOTIENT FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Habitat	Number of Hotspot Locations
Arsenic	DITCHES	17
	MARSH SURFACE	25
	NICHOLS CREEK	2
	RASS 3 & 4 UPLAND	1
	SLOUGH	18
Cadmium	DITCHES	15
	MARSH SURFACE	11
	NICHOLS CREEK	5
	RASS 3 & 4 UPLAND	6
	RASS 3 POND	4
	SLOUGH	25
Copper	DITCHES	20
	MARSH SURFACE	29
	NICHOLS CREEK	2
	SLOUGH	18
Lead	DITCHES	11
	MARSH SURFACE	30
	NICHOLS CREEK	8
	RASS 3 & 4 UPLAND	4
	RASS 3 POND	3
	RASS 4 WETLAND	1
	SLOUGH	4
Mercury	RASS 3 & 4 UPLAND	5
Selenium	DITCHES	8
	MARSH SURFACE	8
	RASS 3 & 4 UPLAND	5
	RASS 4 WETLAND	2
	SLOUGH	5
Zinc	DITCHES	9
	MARSH SURFACE	10
	NICHOLS CREEK	13
	RASS 3 POND	5
	SLOUGH	25
Mean ER-Mq	DITCHES	8
	MARSH SURFACE	17
	NICHOLS CREEK	4
	RASS 3 & 4 UPLAND	3
	RASS 3 POND	3
	SLOUGH	17

Notes: Hotspots were defined as metal concentrations or mean ER-Mqs that exceeded 1.5 times the interquartile range for the distribution of conentrations or values using data for each sampling year and each location. The interquartile range is defined as the difference between the 75th and 25th percentile of the distribution.

$ER\text{-}M_q$ Mean effects range-median quotient for 7 metals.

TABLE 65

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Arsenic	R01DH067	Ditches	5	3,260
	R01SS083	Marsh Surface	5	1,960
	R01SS078	Marsh Surface	5	1,800
	R01DH266	Ditches	4	1,770
	R01SS091	Marsh Surface	5	1,270
	R01SS108	Marsh Surface	5	1,250
	R01DH249	Ditches	1	1,110
	R01SS264	Marsh Surface	3	1,110
	R01SH077	Slough	3	1,060
	R01DH100	Ditches	5	928
	R01SS128	Marsh Surface	3	903
	R01SS106	Marsh Surface	1	705
	R01SS253	Marsh Surface	4	636
	R01SS084	Marsh Surface	4	632
	R01DH241	Ditches	2	570
	R01SS089	Marsh Surface	3	545
	R02SS267	Marsh Surface	1	528
	R01DH250	Ditches	1	524
	R01SH254	Slough	2	508
	R01SH051	Slough	1	487
	R01DH261	Ditches	3	473
	R01SH075	Slough	2	451
	R01DH265	Ditches	4	422
	R01SS107	Marsh Surface	1	418
	R01DH120	Ditches	4	416
	R01SS103	Marsh Surface	1	385
	R01SS076	Marsh Surface	2	377
	R01SH058	Slough	1	368
	R01DH240	Ditches	3	366
	R01DH113	Ditches	2	365
	R02SS269	Marsh Surface	1	346
	R01SH130	Slough	1	331
	R01SH255	Slough	2	317
	R01SH251	Slough	1	310
	R01SS062	Marsh Surface	3	302
	R01SH244	Slough	1	295
	R01DH248	Ditches	3	283
	R01SH256	Slough	1	281
	R01DH092	Ditches	5	276
	R01SH098	Slough	1	265
	R01SS125	Marsh Surface	2	262
	R01SS119	Marsh Surface	1	259
	R01SS258	Marsh Surface	1	230
	R02SS149	Marsh Surface	1	230
	R01SH257	Slough	1	228

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Arsenic	R02SS150	Marsh Surface	2	212
	R01SH118	Slough	2	212
	R01DH260	Ditches	2	211
	R01SH055	Slough	1	210
	R01DH090	Ditches	1	209
	R04SS192	RASS 3 and 4 Upland	2	206
	R01SH046	Slough	1	204
	R01SS088	Marsh Surface	2	195
	R01SS104	Marsh Surface	1	191
	R03SH159	Nichols Creek	2	190
	R01DH099	Ditches	1	184
	R03SH278	Nichols Creek	1	179
	R01DH259	Ditches	3	175
	R01SH082	Slough	1	166
	R01SH245	Slough	1	165
	R01SH081	Slough	1	149
	R01SS095	Marsh Surface	1	137
	R02SS137	Marsh Surface	1	137
Cadmium	R01SH251	Slough	3	832
	R01SH244	Slough	3	304
	R01DH265	Ditches	3	148
	R01SH111	Slough	4	124
	R01SH254	Slough	2	111
	R01SH097	Slough	3	108
	R01SH081	Slough	1	94.0
	R01SH236	Slough	1	64.9
	R01SH075	Slough	1	63.8
	R01SH074	Slough	2	63.4
	R03WD155	RASS 3 Pond	1	55.7
	R01SH098	Slough	3	40.4
	R01DH266	Ditches	2	40.1
	R01SH245	Slough	2	40.1
	R02SS149	Marsh Surface	2	38.6
	R01SH082	Slough	3	37.7
	R01SH077	Slough	1	33.5
	R01DH120	Ditches	2	26.7
	R01SH256	Slough	2	22.5
	R04SS192	RASS 3 and 4 Upland	4	22.1
	R01SH252	Slough	2	21.8
	R01DH096	Ditches	1	21.4
	R01SH105	Slough	1	20.3
	R03SH186	Nichols Creek	2	19.4
	R01SH112	Slough	2	19.1
	R01SH247	Slough	1	18.7
	R01DH090	Ditches	3	18.5

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Cadmium	R03WD152	RASS 3 Pond	2	17.6
	R01DH099	Ditches	1	16.5
	R01SS083	Marsh Surface	1	16.4
	R02SS144	Marsh Surface	1	16.1
	R03SH187	Nichols Creek	1	15.8
	R01DH067	Ditches	1	15.7
	R02SS150	Marsh Surface	1	15.6
	R03WD156	RASS 3 Pond	2	15.3
	R03SH270	Nichols Creek	2	15.0
	R01SS135	Marsh Surface	3	14.7
	R01SS109	Marsh Surface	1	14.6
	R04SS198	RASS 3 and 4 Upland	2	14.4
	R01DH261	Ditches	1	14.3
	R02SS148	Marsh Surface	5	14.0
	R01SS264	Marsh Surface	1	13.7
	R03WD153	RASS 3 Pond	1	13.4
	R01SH050	Slough	1	13.1
	R01SH239	Slough	1	13.1
	R01SH243	Slough	1	12.9
	R02SS137	Marsh Surface	1	12.5
	R02SS271	Marsh Surface	2	12.2
	R01SH133	Slough	1	12.2
	R01SH132	Slough	2	12.1
	R04SS196	RASS 3 and 4 Upland	1	11.7
	R01DH121	Ditches	3	11.6
	R01DH100	Ditches	1	11.3
	R01SH134	Slough	1	11.3
	R04SS193	RASS 3 and 4 Upland	2	10.2
	R01DH241	Ditches	1	10.1
	R01SS128	Marsh Surface	1	10.1
	R04SS200	RASS 3 and 4 Upland	2	9.9
	R03SH181	Nichols Creek	2	9.4
	R01DH124	Ditches	2	9.1
	R03SH275	Nichols Creek	1	9.1
	R01DH113	Ditches	1	8.9
	R01DH052	Ditches	1	8.8
	R01DH057	Ditches	1	8.4
	R04SS201	RASS 3 and 4 Upland	1	8.4
	R01SH130	Slough	1	8.4
Copper	R01SS083	Marsh Surface	4	1560
	R01DH265	Ditches	4	1540
	R01DH266	Ditches	4	1400
	R01SS128	Marsh Surface	4	1370
	R01SS062	Marsh Surface	5	1350
	R01DH113	Ditches	4	1320

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
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Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Copper	R01SS264	Marsh Surface	2	1270
	R01SH251	Slough	1	1140
	R01SS078	Marsh Surface	3	992
	R01DH259	Ditches	2	898
	R02SS269	Marsh Surface	2	894
	R01SS084	Marsh Surface	3	813
	R02SS149	Marsh Surface	1	802
	R01DH090	Ditches	2	712
	R01SH058	Slough	1	689
	R01SS107	Marsh Surface	1	678
	R01DH241	Ditches	2	670
	R01DH120	Ditches	4	649
	R01SS108	Marsh Surface	3	627
	R01SS119	Marsh Surface	3	621
	R01SS109	Marsh Surface	1	616
	R01DH249	Ditches	1	610
	R01SH074	Slough	3	596
	R01DH100	Ditches	2	595
	R01SH131	Slough	1	586
	R01SS135	Marsh Surface	3	577
	R02SS137	Marsh Surface	2	572
	R01DH067	Ditches	5	569
	R01SH132	Slough	1	518
	R01SH244	Slough	1	479
	R02SS207	Marsh Surface	1	443
	R01SS089	Marsh Surface	3	424
	R01SH097	Slough	1	423
	R02SS268	Marsh Surface	1	411
	R01DH121	Ditches	1	403
	R01DH099	Ditches	1	392
	R01SH235	Slough	1	392
	R01DH250	Ditches	2	388
	R01SH105	Slough	1	381
	R01DH261	Ditches	3	375
	R01SS106	Marsh Surface	1	371
	R01SH245	Slough	1	367
	R01SS253	Marsh Surface	3	364
	R02SS271	Marsh Surface	2	362
	R01SS125	Marsh Surface	1	357
	R01SH081	Slough	1	357
	R01DH092	Ditches	1	356
	R02SS150	Marsh Surface	1	355
	R01SS258	Marsh Surface	1	352
	R01SH077	Slough	1	351
	R01SH098	Slough	1	351

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Copper	R01SS091	Marsh Surface	2	346
	R01SH239	Slough	1	344
	R01SH051	Slough	1	336
	R03SH273	Nichols Creek	1	327
	R01DH248	Ditches	1	313
	R01SS076	Marsh Surface	1	299
	R01SS088	Marsh Surface	1	291
	R01SS138	Marsh Surface	1	291
	R01DH052	Ditches	1	290
	R03SH186	Nichols Creek	2	285
	R01SH134	Slough	1	284
	R02SS148	Marsh Surface	1	280
	R01DH096	Ditches	1	275
	R01SS042	Marsh Surface	2	268
	R01SH236	Slough	1	268
	R01DH061	Ditches	1	261
	R01DH240	Ditches	1	261
	R01SH075	Slough	1	258
Lead	R02SS149	Marsh Surface	1	6060
	R04SS198	RASS 3 and 4 Upland	4	5980
	R03SH186	Nichols Creek	2	2990
	R04SS202	RASS 3 and 4 Upland	4	1880
	R04SS200	RASS 3 and 4 Upland	5	1360
	R01SS135	Marsh Surface	3	1010
	R03SH283	Nichols Creek	1	951
	R03SH270	Nichols Creek	2	907
	R02SS137	Marsh Surface	3	724
	R02SS271	Marsh Surface	2	509
	R01SS264	Marsh Surface	2	493
	R02SS148	Marsh Surface	2	491
	R02SS272	Marsh Surface	2	480
	R01DH249	Ditches	1	475
	R04SS194	RASS 3 and 4 Upland	1	450
	R01DH266	Ditches	1	444
	R02SS142	Marsh Surface	1	414
	R04WD195	RASS 4 Wetland	2	413
	R03WD156	RASS 3 Pond	2	408
	R03SH181	Nichols Creek	2	367
	R02SS269	Marsh Surface	1	345
	R01SS138	Marsh Surface	2	332
	R01SH251	Slough	1	331
	R01SS078	Marsh Surface	1	312
	R02SS268	Marsh Surface	2	300
	R03WD152	RASS 3 Pond	2	285
	R01SS089	Marsh Surface	2	277

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Lead	R01SS103	Marsh Surface	4	277
	R01DH117	Ditches	1	266
	R01SS083	Marsh Surface	4	261
	R01SS062	Marsh Surface	2	260
	R01SS107	Marsh Surface	1	260
	R01DH248	Ditches	1	255
	R03SH273	Nichols Creek	1	245
	R01SS031	Marsh Surface	1	232
	R01SH131	Slough	1	231
	R01SS102	Marsh Surface	2	228
	R01DH259	Ditches	2	226
	R01SS128	Marsh Surface	3	219
	R01SH132	Slough	1	209
	R01DH263	Ditches	1	204
	R02SS267	Marsh Surface	1	204
	R01DH067	Ditches	2	199
	R01SS091	Marsh Surface	2	196
	R01DH100	Ditches	1	188
	R03SH279	Nichols Creek	1	188
	R03WD155	RASS 3 Pond	1	184
	R01SS095	Marsh Surface	1	183
	R01SS108	Marsh Surface	2	182
	R01SS084	Marsh Surface	1	178
	R01SS119	Marsh Surface	2	178
	R01SH244	Slough	1	178
	R01SS072	Marsh Surface	1	177
	R01DH241	Ditches	1	175
	R01SS253	Marsh Surface	2	171
	R03SH159	Nichols Creek	1	168
	R01DH090	Ditches	1	167
	R01SS076	Marsh Surface	1	166
	R01SS104	Marsh Surface	1	166
	R01DH113	Ditches	1	158
	R03SH184	Nichols Creek	1	156
Mercury	R04SS200	RASS 3 and 4 Upland	4	143
	R04SS201	RASS 3 and 4 Upland	1	44.4
	R04SS198	RASS 3 and 4 Upland	4	38.8
	R04SS202	RASS 3 and 4 Upland	4	19.9
	R04SS194	RASS 3 and 4 Upland	2	10.0
Selenium	R04SS198	RASS 3 and 4 Upland	4	657
	R04SS200	RASS 3 and 4 Upland	5	482
	R04SS202	RASS 3 and 4 Upland	4	109
	R04WD195	RASS 4 Wetland	2	16.0
	R04SS194	RASS 3 and 4 Upland	2	13.8
	R04SS201	RASS 3 and 4 Upland	4	12.7

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Selenium	R01SS089	Marsh Surface	2	9.6
	R01SS119	Marsh Surface	1	9.4
	R01SS108	Marsh Surface	1	8.9
	R01DH067	Ditches	4	7.6
	R01SS128	Marsh Surface	1	7.6
	R01DH052	Ditches	1	7.5
	R01SS083	Marsh Surface	1	7.1
	R01SH252	Slough	1	7.0
	R01DH100	Ditches	1	6.9
	R01DH073	Ditches	1	6.6
	R01SH251	Slough	1	6.5
	R01DH120	Ditches	1	6.4
	R01DH266	Ditches	1	6.1
	R01SS076	Marsh Surface	1	6.1
	R04WD199	RASS 4 Wetland	1	6.1
	R01SH075	Slough	1	6.1
	R01SH231	Slough	1	6.1
	R01DH265	Ditches	2	6.0
	R01SS078	Marsh Surface	2	6.0
	R01DH090	Ditches	1	5.8
	R02SS271	Marsh Surface	1	5.8
	R01SH077	Slough	1	5.5
Zinc	R01SH251	Slough	4	89300
	R01SH244	Slough	3	28500
	R03WD155	RASS 3 Pond	1	23100
	R01SH254	Slough	2	19500
	R03SH186	Nichols Creek	2	16800
	R01SH081	Slough	2	15000
	R01SH097	Slough	2	15000
	R01SH098	Slough	2	12400
	R01DH265	Ditches	3	11700
	R02SS149	Marsh Surface	1	10800
	R01SH082	Slough	3	10100
	R01SH111	Slough	2	9500
	R03SH282	Nichols Creek	1	8870
	R01SH245	Slough	2	8420
	R01SH247	Slough	1	7770
	R03SH270	Nichols Creek	2	7120
	R02SS271	Marsh Surface	3	6750
	R03SH283	Nichols Creek	2	6620
	R01SH075	Slough	1	6140
	R01SH077	Slough	1	5840
	R01SS135	Marsh Surface	3	5790
	R01SH131	Slough	1	5750
	R01SH074	Slough	3	5580

TABLE 65 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CONCENTRATIONS OF SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Habitat	Number of Rounds	Maximum Concentration (mg/kg)
Zinc	R03WD156	RASS 3 Pond	2	5360
	R03WD152	RASS 3 Pond	2	5060
	R01SH112	Slough	2	5050
	R03SH185	Nichols Creek	1	4990
	R02SS148	Marsh Surface	5	4980
	R01SH132	Slough	2	4970
	R01SS109	Marsh Surface	1	4940
	R03SH181	Nichols Creek	3	4920
	R03SH284	Nichols Creek	1	4530
	R01DH266	Ditches	2	4220
	R03SH273	Nichols Creek	1	4030
	R02SS150	Marsh Surface	1	3880
	R01SH134	Slough	1	3740
	R03WD157	RASS 3 Pond	2	3690
	R03SH187	Nichols Creek	2	3680
	R01SH252	Slough	2	3630
	R01SH130	Slough	1	3580
	R01SS103	Marsh Surface	1	3380
	R01DH241	Ditches	2	3330
	R01DH090	Ditches	2	3320
	R01DH096	Ditches	1	3300
	R01DH120	Ditches	2	3210
	R01SH256	Slough	2	2980
	R01SH239	Slough	1	2920
	R01SH105	Slough	1	2890
	R01SH243	Slough	1	2880
	R03SH184	Nichols Creek	1	2870
	R01SH133	Slough	1	2860
	R01SS102	Marsh Surface	1	2790
	R03SH165	Nichols Creek	1	2780
	R01DH052	Ditches	1	2750
	R02SS137	Marsh Surface	1	2670
	R01DH117	Ditches	1	2650
	R01DH100	Ditches	1	2600
	R03SH163	Nichols Creek	1	2590
	R01SH236	Slough	1	2590
	R03WD153	RASS 3 Pond	1	2490
	R01SS242	Marsh Surface	1	2380
	R03SH275	Nichols Creek	1	2370

Notes: Hotspots were defined as metal concentrations that exceeded 1.5 times the interquartile range for the distribution of concentrations using data for each sampling year and each location. The interquartile range is defined as the difference between the 75th and 25th percentile of the distribution.

Number of rounds gives the number of sampling rounds in which the metal was identified as a hotspot based on the definition provided above (5 total rounds).

The table is sorted by decreasing maximum hotspot concentration for each location for each of the seven metals.

TABLE 66

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CALCULATION OF THE MEAN ER-M QUOTIENT FOR SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Habitat	Number of Sampling Rounds	Maximum Mean ER-Mq	Percent Contribution of Individual Metals to the Maximum Mean ER-Mq at Each Location						
				As	Cd	Cu	Hg	Pb	Se	Zn
R04SS198	RASS 3 and 4 Upland	4	72.3	0	0	0	1	5	**93**	0
R04SS200	RASS 3 and 4 Upland	4	54.1	0	0	0	7	2	**91**	0
R01SH251	Slough	4	52.9	1	**27**	1	--	0	1	**69**
R01SH244	Slough	1	18.5	4	**29**	2	--	1	3	**63**
R04SS202	RASS 3 and 4 Upland	4	16.5	0	0	0	24	7	**67**	0
R02SS149	Marsh Surface	1	10.8	5	6	5	--	**43**	0	**41**
R03WD155	RASS 3 Pond	1	10.6	0	9	0	--	1	0	**89**
R01SH254	Slough	1	10.5	2	18	1	--	0	2	**76**
R01DH265	Ditches	3	10.1	10	**25**	9	--	1	7	**47**
R04SS201	RASS 3 and 4 Upland	1	9.8	1	1	0	**91**	0	6	1
R03SH186	Nichols Creek	2	9.6	0	3	2	--	21	2	71
R01DH067	Ditches	5	9.5	**82**	0	4	--	2	10	4
R01SH081	Slough	1	9.0	4	18	2	--	1	6	**68**
R01SH097	Slough	1	8.8	3	21	3	--	1	4	**69**
R01DH266	Ditches	4	6.8	**62**	0	13	--	5	11	10
R01SH098	Slough	1	6.7	1	10	3	--	1	8	**75**
R01SH111	Slough	2	6.7	2	**32**	2	--	1	5	**58**
R01SS083	Marsh Surface	3	6.3	**74**	0	4	--	3	13	5
R01SH082	Slough	1	5.4	7	12	2	--	2	1	**76**
R01SH245	Slough	1	5.0	8	14	4	--	2	4	**68**
R01SS078	Marsh Surface	2	4.9	**88**	0	4	--	2	2	3
R01DH100	Ditches	1	4.6	**48**	0	8	--	3	18	23
R01SS128	Marsh Surface	2	4.4	**49**	2	19	--	4	21	5
R01SH247	Slough	1	4.4	7	7	3	--	2	9	72
R01SS264	Marsh Surface	2	4.4	**55**	5	18	--	5	3	13
R01SS091	Marsh Surface	3	4.2	**72**	0	5	--	4	13	6
R01SS108	Marsh Surface	2	4.2	**61**	0	8	2	3	22	4
R01DH249	Ditches	1	4.1	**64**	3	9	--	9	5	9
R03SH270	Nichols Creek	2	4.0	1	6	3	--	17	1	**72**
R04SS194	RASS 3 and 4 Upland	1	3.9	2	2	1	**51**	7	36	1
R01DH241	Ditches	1	3.9	**35**	4	11	--	2	15	**34**
R01SS135	Marsh Surface	2	3.9	2	5	9	--	20	3	**61**
R02SS271	Marsh Surface	2	3.8	2	6	4	--	5	11	**71**
R03SH282	Nichols Creek	1	3.8	0	3	0	--	0	1	**96**
R01DH120	Ditches	2	3.7	20	12	11	--	3	20	**34**
R01SH075	Slough	1	3.7	3	**26**	4	3	1	6	**58**
R03SH283	Nichols Creek	1	3.6	1	1	2	--	20	2	**75**

TABLE 66 (Continued)

SEDIMENT AND SOIL LOCATIONS AT THE LITIGATION AREA IDENTIFIED AS HOTSPOTS BASED ON CALCULATION OF THE MEAN ER-M QUOTIENT FOR SEVEN METALS FROM MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Habitat	Number of Sampling Rounds	Maximum Mean ER-Mq	Percent Contribution of Individual Metals to the Maximum Mean ER-Mq at Each Location						
				As	Cd	Cu	Hg	Pb	Se	Zn
R01SH074	Slough	1	3.6	2	21	6	--	1	6	**63**
R01SH077	Slough	2	3.5	9	16	4	--	1	3	**67**
R03WD156	RASS 3 Pond	1	3.3	2	8	3	--	9	12	**66**
R01SS109	Marsh Surface	1	3.3	9	8	12	--	1	9	**61**
R01SS089	Marsh Surface	1	3.1	**42**	0	9	--	7	**37**	5
R01SS253	Marsh Surface	2	3.1	**50**	5	4	--	3	20	19
R01SH131	Slough	1	2.9	2	2	11	2	5	9	**68**
R01SH112	Slough	1	2.9	2	11	3	--	2	12	**70**
R03WD152	RASS 3 Pond	1	2.9	8	10	3	--	7	1	**70**
R01SH132	Slough	2	2.9	4	7	4	--	3	12	**70**
R01SS062	Marsh Surface	1	2.9	**25**	2	**29**	--	7	17	20
R01SH130	Slough	1	2.9	**28**	5	3	--	1	12	**51**
R02SS148	Marsh Surface	1	2.8	2	6	6	--	13	1	**71**
R01SS106	Marsh Surface	1	2.7	**62**	0	8	--	3	20	7
R02SS150	Marsh Surface	1	2.7	19	10	8	--	4	2	**58**
R01DH113	Ditches	1	2.6	**33**	0	**31**	--	5	17	15
R02SS137	Marsh Surface	1	2.6	12	8	13	--	21	4	**41**

Notes: Table is sorted by decreasing ER-M_q.

Bold Percent contributions to the mean ER-M_q greater than or equal to 25 percent.

Percentages are rounded to the nearest one percent and may not total to 100 in all cases.

Hotspots were defined as mean ER-M_qs that exceeded 1.5 times the interquartile range for the distribution of values using data for each sampling year and each location. The interquartile range is defined as the difference between the 75th and 25th percentile of the distribution.

Number of rounds gives the number of sampling rounds (five total) in which the metal was identified as a hotspot.

ER-Mq Mean effects-range median quotient for seven metals

-- Analyte not measured

TABLE 67

SUMMARY OF TOTAL METAL CONCENTRATIONS IN SURFACE WATER
FROM MONITORING YEARS 1 THROUGH 5
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Habitat	Metal	Number of Locations	Summary Statistics for Location Means						Surface Water Screening Criteria	
			Minimum (µg/L)	Median (µg/L)	Maximum (µg/L)	Mean (µg/L)	S.D. (µg/L)	UCL_{95} (µg/L)	Acute	Chronic
Slough	Arsenic	55	1.61	4.01	220.05	13.26	35.24	21.21	69	36
	Cadmium	55	0.14	0.26	40.71	1.92	7.09	3.50	21.6	7.3
	Copper	55	3.13	7.99	364.95	**26.87**	65.84	**41.73**	5.8	3.7
	Lead	55	0.73	1.93	123.76	10.04	27.39	16.18	220.8	8.5
	Selenium	55	0.95	1.40	4.19	1.51	0.53	1.50	290.6	5.0
	Zinc	55	16.33	75.51	14,792.33	**621.26**	2,399.18	**1,162.66**	95.1	85.6
Ditches	Arsenic	38	1.38	25.41	668.81	**81.74**	157.73	**124.91**	69	36
	Cadmium	38	0.13	0.38	45.47	4.04	9.17	6.55	21.6	7.3
	Copper	38	3.23	23.49	1,539.25	**134.23**	298.44	**215.91**	5.8	3.7
	Lead	38	0.66	6.06	332.93	38.65	74.31	58.76	220.8	8.5
	Mercury	1	0.39	0.39	0.39	0.39	NA	NA	1.6	0.025
	Selenium	38	0.95	1.41	12.90	1.93	1.93	2.42	290.6	5.0
	Zinc	38	11.37	206.21	6,838.56	**886.46**	1,526.58	**1,304.25**	95.1	85.6
Nichols Creek	Arsenic	29	1.88	4.33	36.67	6.57	7.12	8.82	69	36
	Cadmium	29	0.15	0.93	124.69	6.44	23.04	13.71	21.6	7.3
	Copper	29	1.00	4.18	169.50	**22.32**	40.61	**35.15**	5.8	3.7
	Lead	29	0.85	4.55	279.05	37.93	68.18	59.46	220.8	8.5
	Selenium	29	1.10	1.70	5.06	2.15	1.17	2.29	290.6	5.0
	Zinc	29	19.48	440.36	52,625.50	**2,749.73**	9,761.44	**5,833.29**	95.1	85.6
Nichols Creek Reference	Arsenic	3	4.51	8.30	10.63	7.81	3.09	13.02	69	36
	Cadmium	3	0.16	0.24	0.45	0.28	0.15	0.50	21.6	7.3
	Copper	3	13.16	33.26	37.95	28.12	13.17	**50.33**	5.8	3.7
	Lead	3	9.65	19.79	26.27	18.57	8.38	32.69	220.8	8.5
	Mercury	3	0.06	0.06	0.06	0.06	0.00	0.06	1.6	0.025
	Selenium	3	3.43	4.51	4.74	4.23	0.70	5.13	290.6	5.0
	Zinc	3	57.01	89.38	127.31	**91.23**	35.19	**150.55**	95.1	85.6
RASS 3 Pond	Arsenic	5	2.77	3.91	9.75	5.48	3.23	8.55	69	36
	Cadmium	5	0.16	0.70	2.58	1.06	0.93	1.91	21.6	7.3
	Copper	5	9.03	13.39	34.97	**17.01**	10.55	**27.07**	5.8	3.7
	Lead	5	2.68	12.26	33.32	17.09	13.04	29.52	220.8	8.5
	Selenium	5	1.20	1.21	2.27	1.62	0.56	2.15	290.6	5.0
	Zinc	5	102.73	442.25	696.39	**458.61**	242.66	**689.96**	95.1	85.6
RASS 4 Wetland	Arsenic	4	3.23	37.76	56.44	33.80	26.67	65.17	69	36
	Cadmium	4	0.17	0.37	3.51	1.11	1.60	2.99	21.6	7.3
	Copper	4	5.71	51.79	332.90	**110.55**	152.58	**290.09**	5.8	3.7
	Lead	4	2.80	33.39	263.23	83.20	123.08	**228.03**	220.8	8.5
	Mercury	4	0.07	0.11	0.54	0.21	0.22	0.45	1.6	0.025
	Selenium	4	1.03	2.14	3.18	2.12	0.93	3.21	290.6	5.0
	Zinc	4	16.06	240.90	1,605.43	**525.82**	743.62	**1,400.82**	95.1	85.6
Sitewide	Arsenic	134	1.38	4.76	668.81	31.43	92.12	44.61	69	36
	Cadmium	134	0.13	0.32	124.69	3.41	12.62	5.20	21.6	7.3
	Copper	134	1.00	10.12	1,539.25	**58.49**	172.97	**83.24**	5.8	3.7
	Lead	134	0.66	2.80	332.93	26.83	58.75	35.15	220.8	8.5
	Mercury	8	0.06	0.08	0.54	0.17	0.18	0.28	1.6	0.025
	Selenium	134	0.95	1.51	12.90	1.85	1.30	1.91	290.6	5.0
	Zinc	134	11.37	132.21	52,625.50	**1,136.32**	4,879.35	**1,834.51**	95.1	85.6

Notes: All statistics are based on the grand means for monitoring years 1 through 5 at each location.
One-half of the validated result was substituted for all nondetected analytes.
Shaded cells indicate concentrations that exceed the chronic benchmark.
Bolded cells indicate concentrations that exceed the acute benchmark.

µg/L Microgram per liter
NA Not applicable
S.D. Standard deviation of the arithmetic mean
UCL_{95} One-side 95 percent upper confidence limit of the arithmetic mean assuming a normal distribution

TABLE 68

SUMMARY OF DISSOLVED METAL CONCENTRATIONS IN SURFACE WATER FROM MONITORING YEARS 4 AND 5
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Habitat	Metal	Number of Locations	Summary Statistics for Location Means					Surface Water Screening Criteria[a]	
			Minimum (µg/L)	Median (µg/L)	Maximum (µg/L)	Mean (µg/L)	S.D. (µg/L)	Acute	Chronic
Slough	Arsenic	16	1.05	2.95	6.50	2.91	1.67	69	36
	Cadmium	16	0.15	0.15	0.30	0.21	0.07	19.1	6.2
	Copper	16	1.50	17.81	34.00	**16.94**	12.57	4.8	3.1
	Lead	16	0.50	0.85	2.70	0.93	0.57	210	8.1
	Selenium	16	1.10	1.25	2.20	1.36	0.36	290	4.6
	Zinc	16	8.45	33.35	124.00	45.76	32.11	90	81
Ditches	Arsenic	6	7.40	20.80	109.00	41.43	42.19	69	36
	Cadmium	6	0.15	0.15	0.50	0.24	0.15	19.1	6.2
	Copper	6	1.70	16.60	139.00	**33.95**	51.99	4.8	3.1
	Lead	6	0.50	1.28	2.50	1.35	0.74	210	8.1
	Selenium	6	1.25	1.25	1.25	1.25	0.00	290	4.6
	Zinc	6	0.50	16.23	31.60	16.62	12.84	90	81
Nicholos Creek	Arsenic	2	1.35	1.58	1.80	1.58	0.32	69	36
	Cadmium	2	0.15	0.15	0.15	0.15	0.00	19.1	6.2
	Copper	2	14.50	17.30	20.10	**17.30**	3.96	4.8	3.1
	Lead	2	0.85	0.85	0.85	0.85	0.00	210	8.1
	Selenium	2	1.25	2.33	3.40	2.33	1.52	290	4.6
	Zinc	2	1.80	2.03	2.25	2.03	0.32	90	81
Nichols Creek Reference	Arsenic	1	4.35	4.35	4.35	4.35	NA	69	36
	Cadmium	1	0.15	0.15	0.15	0.15	NA	19.1	6.2
	Copper	1	41.90	41.90	41.90	**41.90**	NA	4.8	3.1
	Lead	1	0.85	0.85	0.85	0.85	NA	210	8.1
	Selenium	1	3.05	3.05	3.05	3.05	NA	290	4.6
	Zinc	1	1.70	1.70	1.70	1.70	NA	90	81
RASS 3 Pond	Arsenic	2	1.05	1.13	1.20	1.13	0.11	69	36
	Cadmium	2	0.23	0.26	0.30	0.26	0.05	19.1	6.2
	Copper	2	3.45	6.26	9.08	**6.26**	3.98	4.8	3.1
	Lead	2	0.85	0.85	0.85	0.85	0.00	210	8.1
	Selenium	2	1.10	1.14	1.18	1.14	0.05	290	4.6
	Zinc	2	15.30	17.98	20.65	17.98	3.78	90	81
Sitewide	Arsenic	27	1.05	3.18	109.00	11.29	24.78	69	36
	Cadmium	27	0.15	0.15	0.50	0.21	0.09	19.1	6.2
	Copper	27	1.50	15.90	139.00	**20.88**	26.38	4.8	3.1
	Lead	27	0.50	0.85	2.70	1.01	0.57	210	8.1
	Selenium	27	1.10	1.25	3.40	1.45	0.59	290	4.6
	Zinc	27	0.50	21.90	124.00	32.35	30.29	90	81

Notes: All statistics are based on first calculating the means for monitoring years 4 and 5 at each location.
One-half of the validated result was substituted for all nondetected analytes.
Shaded cells indicate concentrations that exceed the chronic benchmark.
Bolded cells indicate concentrations that exceed the acute benchmark.

a Additional details regarding the surface water criteria are provided in Tables 10A and 10B.

µg/L Microgram per liter

NA Not applicable

S.D. Standard deviation of the arithmetic mean

TABLE 69

COMPARISON OF LITIGATION AREA SOIL AND SEDIMENT METAL CONCENTRATIONS TO OAK RIDGE NATIONAL LABORATORY TOXICITY BENCHMARKS FOR PLANTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Summary Statistics for Litigation Area Soil and Sediment Location Means[1]							ORNL		Number of
Habitat	Metal	Number of Locations	Minimum (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Maximum (mg/kg)	S.D.[2] (mg/kg)	UCL_{95}[3] (mg/kg)	Benchmark (mg/kg)	Habitat UCL_{95} (mg/kg)	Locations >ORNL Benchmark
Marsh Reference	Arsenic	5	4.18	10.96	12.58	17.20	6.19	16.86	10.00	Y	3
	Cadmium	5	0.09	0.25	0.20	0.41	0.14	0.38	4.00	N	0
	Copper	5	8.43	35.50	31.56	67.90	25.29	59.61	100.00	N	0
	Lead	5	8.74	33.12	32.96	70.14	23.97	55.97	50.00	Y	1
	Mercury	5	0.01	0.13	0.04	0.34	0.15	0.28	0.30	N	1
	Selenium	5	0.30	0.94	0.88	2.00	0.70	1.61	1.00	Y	2
	Zinc	5	38.02	95.49	75.72	152.86	53.07	146.08	50.00	Y	4
Marsh Surface	Arsenic	78	8.98	106.98	29.76	1,012.80	193.53	143.46	10.00	Y	77
	Cadmium	78	0.07	1.67	0.80	12.12	2.33	2.10	4.00	N	9
	Copper	78	38.88	161.18	91.17	881.28	156.64	190.71	100.00	Y	36
	Lead	78	26.36	109.54	77.35	1,225.66	146.34	137.12	50.00	Y	50
	Mercury	18	0.05	0.33	0.31	0.72	0.20	0.41	0.30	Y	9
	Selenium	78	0.30	1.47	1.04	4.81	1.12	1.68	1.00	Y	41
	Zinc	78	122.46	607.92	325.90	3,794.00	770.59	753.18	50.00	Y	78
RASSs 3 and 4 Upland	Arsenic	11	7.40	46.02	39.22	127.18	34.49	64.87	10.00	Y	10
	Cadmium	11	1.37	5.35	5.03	13.60	3.41	7.21	4.00	Y	7
	Copper	11	27.22	46.84	36.66	75.90	18.03	56.69	100.00	N	0
	Lead	11	12.94	340.51	53.98	1,520.60	510.36	619.41	50.00	Y	6
	Mercury	10	0.04	8.07	1.65	44.45	13.71	16.02	0.30	Y	5
	Selenium	11	0.35	31.94	0.85	152.52	56.00	62.54	1.00	Y	5
	Zinc	11	85.82	276.73	148.40	1,550.00	426.12	509.60	50.00	Y	11
RASS 3 Pond	Arsenic	6	7.80	14.14	9.04	38.44	12.04	24.04	10.00	Y	2
	Cadmium	6	2.23	6.85	6.62	12.52	3.88	10.05	4.00	Y	4
	Copper	6	36.44	60.47	56.29	100.44	25.93	81.80	100.00	N	1
	Lead	6	33.22	84.22	55.94	168.73	55.64	129.99	50.00	Y	5
	Mercury	5	0.02	0.04	0.04	0.06	0.02	0.06	0.30	N	0
	Selenium	6	0.45	0.94	0.98	1.42	0.32	1.20	1.00	Y	3
	Zinc	6	1,537.20	2,649.00	2,241.10	5,435.20	1,468.93	3,857.40	50.00	Y	6
RASS 4 Wetland	Arsenic	5	6.80	9.38	8.92	12.40	2.10	11.39	10.00	Y	2
	Cadmium	5	0.14	0.78	0.36	2.70	1.08	1.82	4.00	N	0
	Copper	5	38.28	46.98	45.90	62.18	9.10	55.66	100.00	N	0
	Lead	5	30.40	64.37	32.04	192.18	71.48	132.52	50.00	Y	1
	Mercury	5	0.08	0.26	0.17	0.67	0.23	0.48	0.30	Y	1
	Selenium	5	1.21	2.71	1.83	7.08	2.47	5.07	1.00	Y	5
	Zinc	5	158.40	216.81	184.60	312.25	62.96	276.83	50.00	Y	5
Upland Reference	Arsenic	5	3.20	4.45	4.42	5.76	0.92	5.33	10.00	N	0
	Cadmium	5	0.07	0.15	0.13	0.21	0.06	0.20	4.00	N	0
	Copper	5	17.10	18.55	18.54	20.10	1.40	19.89	100.00	N	0
	Lead	5	16.24	27.69	32.30	37.66	10.51	37.72	50.00	N	0
	Mercury	5	0.04	0.05	0.05	0.09	0.02	0.07	0.30	N	0
	Selenium	5	0.21	0.36	0.37	0.54	0.13	0.48	1.00	N	0
	Zinc	5	57.92	75.72	79.38	90.46	12.25	87.41	50.00	Y	5

Notes: Efroymson, R.A., Me. Will, G.W. Suter II, and A.C. Wooten. 1997. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision." ES/ER/TM-85/. ORNL. Oak Ridge, Tennessee. 128 Pages.

1 Summary statistics are based on means calculated for each location using the years 1-5 monitoring data; one-half the detection limit was submitted for nondetects.

2 Standard deviation of the grand mean for each chemical within each habitat.

3 One-sided UCL_{95}, calculated after equation 11.21 in Gilbert (1987).

mg/kg Milligram per kilogram

ORNL Oak Ridge National Laboratory

S.D. Standard deviation of the grand mean for each chemical within each habitat.

UCL_{95} One-side 95 percent upper confidence limit

TABLE 70

BIOACCUMULATION FACTORS FOR COLLOCATED PICKLEWEED TISSUE AND SOIL DATA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Analyte	Residue Green Pickleweed (mg/kg dw)		Residue Brown Pickleweed (mg/kg dw)		Sample Date	Soil (mg/kg dw)	BAF Green Pickleweed	BAF Brown Pickleweed
MHRSS001	Arsenic	0.1	U	0.09	U	16-Oct-95	5.1	0.0196	0.0176
	Cadmium	0.04		0.02		16-Oct-95	0.05	0.8000	0.4000
	Copper	1.1		3.5		16-Oct-95	9.7	0.1134	0.3608
	Lead	0.97	J	0.12	J	16-Oct-95	7.5	0.1293	0.0160
	Selenium	0.18	U	0.27		16-Oct-95	0.58	0.3103	0.4655
	Zinc	5.1	J	10.5	J	16-Oct-95	38.5	0.1325	0.2727
MHRSS002	Arsenic	0.09	U	0.1	U	16-Oct-95	4.9	0.0184	0.0204
	Cadmium	0.01	U	0.02		16-Oct-95	0.05	0.2000	0.4000
	Copper	0.95		2.8		16-Oct-95	8.4	0.1131	0.3333
	Lead	0.17	J	0.21	J	16-Oct-95	14.1	0.0121	0.0149
	Selenium	0.16	U	0.26		16-Oct-95	0.64	0.2500	0.4063
	Zinc	4.5	J	14.4	J	16-Oct-95	43.7	0.1030	0.3295
MHRSS003	Arsenic	0.09	U	0.1	U	16-Oct-95	14.5	0.0062	0.0069
	Cadmium	0.01	U	0.03		16-Oct-95	0.09	0.1111	0.3333
	Copper	1.4		5.7		16-Oct-95	57.4	0.0244	0.0993
	Lead	1.7	J	0.47	J	16-Oct-95	58.1	0.0293	0.0081
	Selenium	0.16	U	0.25		16-Oct-95	1.6	0.1000	0.1563
	Zinc	8	J	21.1	J	16-Oct-95	111	0.0721	0.1901
MHRSS005	Arsenic	0.08	U	0.17		16-Oct-95	11	0.0073	0.0155
	Cadmium	0.01	U	0.02		16-Oct-95	0.17	0.0588	0.1176
	Copper	0.81		3.4		16-Oct-95	44.9	0.0180	0.0757
	Lead	0.06	J	0.47	J	16-Oct-95	29.9	0.0020	0.0157
	Selenium	0.13	U	0.18	U	16-Oct-95	2.1	0.0619	0.0857
	Zinc	4.1	J	11.6	J	16-Oct-95	104	0.0394	0.1115
R01SS016	Arsenic	0.09	U	0.1	U	16-Oct-95	377	0.0002	0.0003
	Cadmium	0.01	U	0.01	U	16-Oct-95	0.28	0.0357	0.0357
	Copper	0.88		2.4		16-Oct-95	299.00	0.0029	0.0080
	Lead	0.09	J	0.63	J	16-Oct-95	116	0.0008	0.0054
	Selenium	0.16	U	0.31		16-Oct-95	3.4	0.0471	0.0912
	Zinc	4.5	J	12	J	16-Oct-95	116	0.0388	0.1034
R01SS017	Arsenic	0.1	U	0.1	U	16-Oct-95	759	0.0001	0.0001
	Cadmium	0.01	U	0.02		16-Oct-95	0.21	0.0476	0.0952
	Copper	1		4.4		16-Oct-95	310.00	0.0032	0.0142
	Lead	0.07	UJ	0.23	J	16-Oct-95	123	0.0006	0.0019
	Selenium	0.17	U	0.21		16-Oct-95	2.6	0.0654	0.0808
	Zinc	4.3	J	14.6	J	16-Oct-95	310	0.0139	0.0471

TABLE 70 (Continued)

BIOACCUMULATION FACTORS FOR COLLOCATED PICKLEWEED TISSUE AND SOIL DATA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Analyte	Residue Green Pickleweed (mg/kg dw)		Residue Brown Pickleweed (mg/kg dw)		Sample Date	Soil (mg/kg dw)	BAF Green Pickleweed	BAF Brown Pickleweed
R01SS045	Arsenic	0.1		0.19		19-Oct-95	21.8	0.0046	0.0087
	Cadmium	0.02		0.03		19-Oct-95	1.5	0.0133	0.0200
	Copper	0.94		4.3		19-Oct-95	117.00	0.0080	0.0368
	Lead	0.06	U	0.37		19-Oct-95	99.6	0.0006	0.0037
	Selenium	0.16	U	0.38		19-Oct-95	1	0.1600	0.3800
	Zinc	4.6	J	18.8	J	19-Oct-95	413	0.0111	0.0455
R01SS072	Arsenic	0.1		0.1	U	19-Oct-95	195	0.0005	0.0005
	Cadmium	0.01	U	0.02		19-Oct-95	0.15	0.0667	0.1333
	Copper	1.1		3.3		19-Oct-95	168.00	0.0065	0.0196
	Lead	0.07	UJ	0.25	J	19-Oct-95	152	0.0005	0.0016
	Selenium	0.17	U	0.28		19-Oct-95	2.6	0.0654	0.1077
	Zinc	5.4	J	14.3	J	19-Oct-95	201	0.0269	0.0711
R01SS076	Arsenic	0.08	U	0.17		19-Oct-95	259	0.0003	0.0007
	Cadmium	0.01	U	0.02		19-Oct-95	0.21	0.0476	0.0952
	Copper	0.86	U	2.8	U	19-Oct-95	621.00	0.0014	0.0045
	Lead	0.06		0.25		19-Oct-95	165	0.0004	0.0015
	Selenium	0.15	U	0.36		19-Oct-95	9.4	0.0160	0.0383
	Zinc	4.5	J	15.1	J	19-Oct-95	511	0.0088	0.0295
R01SS078	Arsenic	0.1	U	0.44		19-Oct-95	1050	0.0001	0.0004
	Cadmium	0.01	U	0.02		19-Oct-95	0.19	0.0526	0.1053
	Copper	0.75		3.7		19-Oct-95	306.00	0.0025	0.0121
	Lead	0.19	J	0.26	J	19-Oct-95	132	0.0014	0.0020
	Selenium	0.17	U	0.18	U	19-Oct-95	3.5	0.0486	0.0514
	Zinc	4.8	J	17.1	J	19-Oct-95	209	0.0230	0.0818
R01SS088	Arsenic	0.32	U	0.86		12-Oct-95	61.7	0.0052	0.0139
	Cadmium	0.02		0.02		12-Oct-95	0.32	0.0625	0.0625
	Copper	0.76		2.6		12-Oct-95	65.2	0.0117	0.0399
	Lead	0.07	U	0.41		12-Oct-95	108	0.0006	0.0038
	Selenium	0.17	U	0.26	U	12-Oct-95	5.2	0.0327	0.0500
	Zinc	4.5		15.7		12-Oct-95	179	0.0251	0.0877
R01SS089	Arsenic	0.1	U	0.33		19-Oct-95	36	0.0028	0.0092
	Cadmium	0.01	U	0.03		19-Oct-95	0.53	0.0189	0.0566
	Copper	1		3.8		19-Oct-95	140.00	0.0071	0.0271
	Lead	0.07	UJ	0.47	J	19-Oct-95	80.8	0.0009	0.0058
	Selenium	0.18	U	0.29		19-Oct-95	2.6	0.0692	0.1115
	Zinc	9.8	J	22.8	J	19-Oct-95	204	0.0480	0.1118

TABLE 70 (Continued)

BIOACCUMULATION FACTORS FOR COLLOCATED PICKLEWEED TISSUE AND SOIL DATA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Analyte	Residue Green Pickleweed (mg/kg dw)		Residue Brown Pickleweed (mg/kg dw)		Sample Date	Soil (mg/kg dw)	BAF Green Pickleweed	BAF Brown Pickleweed
R01SS091	Arsenic	0.1	U	0.43		12-Oct-95	24.5	0.0041	0.0176
	Cadmium	0.02		0.04		12-Oct-95	0.1	0.2000	0.4000
	Copper	1.2		5.4		12-Oct-95	50.4	0.0238	0.1071
	Lead	0.1		0.34		12-Oct-95	63.5	0.0016	0.0054
	Selenium	0.18	U	0.29	U	12-Oct-95	2.7	0.0667	0.1074
	Zinc	8.5		26.1		12-Oct-95	145	0.0586	0.1800
R01SS104	Arsenic	0.1	U	0.09	U	19-Oct-95	545	0.0002	0.0002
	Cadmium	0.01	U	0.02		19-Oct-95	0.23	0.0435	0.0870
	Copper	1.4		4.4		19-Oct-95	424.00	0.0033	0.0104
	Lead	0.37	J	0.27	J	19-Oct-95	277	0.0013	0.0010
	Selenium	0.18	U	0.26		19-Oct-95	9.6	0.0188	0.0271
	Zinc	5.6	J	16.9	J	19-Oct-95	363	0.0154	0.0466
R01SS119	Arsenic	0.14		0.1	U	12-Oct-95	31.6	0.0044	0.0032
	Cadmium	0.01	U	0.03		12-Oct-95	0.23	0.0435	0.1304
	Copper	1.9		4.3		12-Oct-95	77.1	0.0246	0.0558
	Lead	0.07	U	0.48		12-Oct-95	67.8	0.0010	0.0071
	Selenium	0.18	U	0.2	U	12-Oct-95	2.8	0.0643	0.0714
	Zinc	13.2		33.6		12-Oct-95	205	0.0644	0.1639
R01SS125	Arsenic	0.08		0.18		19-Oct-95	32.4	0.0025	0.0056
	Cadmium	0.01	U	0.04		19-Oct-95	0.12	0.0833	0.3333
	Copper	0.89	U	4.7		19-Oct-95	247.00	0.0036	0.0190
	Lead	0.06	U	0.79		19-Oct-95	113	0.0005	0.0070
	Selenium	0.14	U	0.29		19-Oct-95	2	0.0700	0.1450
	Zinc	6.6	J	29	J	19-Oct-95	557	0.0118	0.0521
R01SS138	Arsenic	0.1		0.1	U	12-Oct-95	44.9	0.0022	0.0022
	Cadmium	0.02		0.05		12-Oct-95	0.12	0.1667	0.4167
	Copper	0.92		1.8		12-Oct-95	72.8	0.0126	0.0247
	Lead	0.07	U	0.07	U	12-Oct-95	96.4	0.0007	0.0007
	Selenium	0.17	U	0.33	U	12-Oct-95	4.7	0.0362	0.0702
	Zinc	5.4		13.1		12-Oct-95	164	0.0329	0.0799

Notes:

BAF Bioaccumulation factor
J Estimated value
mg/kg dw Milligram per kilogram dry weight
U Not detected

TABLE 71

SUMMARY OF ECOLOGICAL EFFECTS OF METALS ON PLANTS
FIVE YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Kind of Plant	Effects	Concentration in Soil	Concentration in Tissue	Reference	Other Comments
Arsenic	*Urtica dioica* (stinging nettle)	Reduced growth	5.01 ppm	Shoot - 0.3 dry weight, Root - 21 dry weight	M.L. Otte 1990	
	Phragmites australis (common reed)	No effect on growth	5.01 ppm	Shoot - 0.127 ppm dry weight, Root - 0.4 ppm dry weight	M.L. Otte 1990	
	Andropogon scoparius (little bluestem)	Survives	41,200 ppm (arsenate)		S. Tamaki 1992	Mode of toxicity is to partially block protein synthesis
	Allium cepa	Reduction in root growth	1.0 ppm		S. Tamaki 1992	
	Allium cepa	Termination of root growth	3.0 ppm		S. Tamaki 1992	
	Typha latifolia (cattail)	Reduced growth and die back of leaf blades	300 ppm		W.T. Dushenko 1995	Leaf uptake may be significant in systems where the concentration in the surrounding lake water column is high.
	Lemon seedlings	Toxicity symptoms		Leaves - 11 ppm dry weight, Root - 260 ppm dry weight	P.F.Reay 1971	Aquatic plants may be more tolerant of arsenic than several other plants. Average concentration in soil is 5 ppm.
	Cerotophyllum demersum			650 ppm	P.F. Reay 1971	
	Lagarosiphon major (Ridley Moss)			251 ppm	P.F. Reay 1971	
	Elodea canadensis			307 ppm	P.F. Reay 1971	
	Potamogeton sp.			178 ppm	P.F. Reay 1971	
	Lemna sp.			30 ppm	P.F. Reay 1971	
	Nitella hookeri			182 ppm	P.F. Reay 1971	
	Hordeum vulgare (barley)				N.R. Benson 1952	Arsenic concentrated in the surface soil. Seasonal difference in toxicity for soils containing lead arsenate. No seasonal difference in toxicity of soluble arsenate. Arsenic is not equally available in all soils. An increase in growth was observed in arsenic contaminated soils with a pH of 6.0 or lower with applications of phosphate fertilizer. Little response to the application of phosphate in the field.
					L.W. Jacobs 1970	As clay, Al_2O_3 and Fe_2O_3 concentration in soils increase arsenic sorption increases. The concentration of organic has no effect on arsenic sorption.
					C.J. Asher and Reay 1979	Arsenic uptake temperature sensitive and inhibited by phosphate.

TABLE 71 (Continued)

SUMMARY OF ECOLOGICAL EFFECTS OF METALS ON PLANTS
FIVE YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Kind of Plant	Effects	Concentration in Soil	Concentration in Tissue	Reference	Other Comments
Cadmium	*Spartina alterniflora* (smooth cordgrass)	Reduced growth	50 ppm	Upper stem - 33.4 ppm dry weight, Lower stem - 36.2 ppm dry weight	R.P. Gambrell and others 1980	Results for Oxidized soils. Upper Stem - mostly leaf tissue with some stem, Lower Stem - Mostly stem tissue
	Distichlis spicata (salt grass)	Reduced growth	50 ppm	Upper stem - 22.3 ppmdry weight, Lower stem - 25.0 ppmdry weight	R.P. Gambrell and others 1980	
	Sorghum halepense (Johnson grass)	Mixed growth results	50 ppm	Upper stem - 233 ppm dry weight, Lower stem - 756 ppm dry weight	R.P. Gambrell and others 1980	
	Zea mays L. (Corn)	50% reduction in net photosynthesis		Leaf - 1.4 *u* mol g^{-1} dry weight	R. Carlson 1975	
	Helianthus annuus L. (sunflower)	Reduction in photosynthesis		Leaf - 3.0 *u* mol g^{-1} dry weight	R. Carlson 1975	Sunflower accumulated significantly more Cd than did corn.
	Andropogon scoparius (little bluestem)	Reduction in root weight, shoot weight and total weight	20 ppm and 40 ppm		L.J. Miles 1980	Root weight more effected than shoot weight. More tolerant of Cd than the other two plants studied.
	Monarda fistulosa (wild bergamot)	Reduction in root weight, shoot weight and total weight	20 ppm		L.J. Miles 1980	Root weight more effected than shoot weight. More tolerant of Cd than the other two plants studied.
	Rudbeckia hirta (black-eyed Susan)	Reduction in root weight, shoot weight and total weight	20 ppm		L.J. Miles 1980	Did not effect the root/shoot ratio.
	Monarda fistulosa (wild bergamot)	Died off	40 ppm		L.J. Miles 1980	
	Rudbeckia hirta (black-eyed Susan)	Died off	40 ppm		L.J. Miles 1980	
	Raphanus sativas (Early Scarlet Globe Radish)	Stunted growth and chlorosis of leaves	100 ppm added to natural content	Shoot - 528 ppm dry weight, Root - 387 ppm dry weight	M. John and others 1972	
	Spinach	Growth inhibition	0.9-1.5 ppm in sand, 0.8-1.8 ppm in sandy clay and 2.4-3.5 ppm in clay		A. Jensen 1991	
	Potatoes	Toxic symptoms	5 ppm in sandy clay but not in sand and clay		A. Jensen 1991	
	Lolium perenne (perennial ryegrass)	No effect on either root or shoot weight		Shoot - 1.2 ppm, 3.9 ppm, 16.4 ppm, and 45.7 ppm dry weight, Root - 1.4 ppm, 99.1 ppm, 410.2 ppm, and 1004.3 ppm dry weight	S.C. Jarvis 1976	

TABLE 71 (Continued)

SUMMARY OF ECOLOGICAL EFFECTS OF METALS ON PLANTS
FIVE YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Kind of Plant	Effects	Concentration in Soil	Concentration in Tissue	Reference	Other Comments
Cadmium (cont'd)	*Typha latifolia* (cattail)	Reduced shoot and root biomass (compared to plants grown in soil with 2 ppm)	73 ppm		S.J. McNaughton and others 1974	No indication that *T. latifolia* has evolved resistant genotypes on heavy metal soils
	Lolium perenne (perennial ryegrass)	No effect on yield	9.8 ppm		W. Dijkshoorn 1981	Acidification of soil contaminated with metalliferous sewage sludge increases the uptake of polluting metals
	Typha latifolia (cattail)		3738 ppm	Aerial tissue - 9-17 ppm dry weight	G. Taylor 1983	*T. latifolia* can exclude Cu from aerial plant tissues.
	Salicornia virginica (Perennial Pickleweed)		from 62 - 493 ppm dry weight	Shoot - from 3.8-52.9 ppm dry weight	F. Demgen 1996	
Copper	*Hallimione portulacoides*	Decreased chlorophyll content	25 ppm		S. Sinha 1998	Effect exhibited after 5 weeks of treatment.
	Hallimione portulacoides	No effect	5 ppm		S. Sinha 1998	No effect after 8 weeks of treatment.
	Agrostis stolonifera	Reduction in root growth	0.5 ppm of soluble copper		B.A. Hunter 1987	
	Agrostis stolonifera		11000 + 1600 ppm	Shoot - 330 ppm dry weight, Root - 70 ppm dry weight	B.A. Hunter 1987	Winter peak in tissue concentration. Increase in tissue concentration of leaves and stems thought to be due to surface deposition of particulates. 25% of these surface particulates are incorporated into the plant tissues as protein-bound or ionic species
	Mimulus guttatus (monkey flower)	Depends on population. Lower seed germination and establishment in populations taken from areas of low Cu concentrations in soil	2700 ppm		W.R. Allen 1971	
	Spartina alterniflora (smooth cordgrass)	Shorter epicotyls and fewer radicles	164.5 ppm	Seeds - 37.1 ppm	D. Waddell 1990	Grown in a control solution and compared to seeds with a tissue concentration of 5.4 ppm from an area with a soil concentration of 42.6 ppm
	Lolium perenne (perennial ryegrass)	No effect on yield	57 ppm		W. Dijkshoorn 1981	Acidification of soil contaminated with metalliferous sewage sludge increases the uptake of polluting metals
	Typha latifolia (cattail)		3738 ppm	Aerial tissue - 9-17 ppm dry weight	G. Taylor 1983	*T. latifolia* can exclude Cu from aerial plant tissues.
	Salicornia virginica (Perennial Pickleweed)		from 62 - 493 ppm dry weight	Shoot - from 3.8-52.9 ppm dry weight	F. Demgen 1996	

TABLE 71 (Continued)

SUMMARY OF ECOLOGICAL EFFECTS OF METALS ON PLANTS
FIVE YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Kind of Plant	Effects	Concentration in Soil	Concentration in Tissue	Reference	Other Comments
Lead	*Typha latifolia* (cattail)	Reduced shoot and root biomass (compared to plants grown in soil with 27 ppm)	435 ppm		S.J. McNaughton and others 1974	No indication that *T. latifolia* has evolved resistant genotypes on heavy metal soils
	Festuca ovina		26,140 ppm	Aerial green parts - 197.0 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Agrostis tenuis		26,140 ppm	Aerial green parts - 169.4 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Armeria maritima		26,140 ppm	Aerial green parts - 395.7 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Viola calaminaria		26,140 ppm	Aerial green parts - 117.0 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf." Pioneer turf consists of blast furnace slags mixed with soil.
	Lolium perenne (perennial ryegrass)	No effect on yield	63 ppm		W. Dijkshoorn 1981	Acidification of soil contaminated with metalliferous sewage sludge increases the uptake of polluting metals
	Salicornia virginica (Perennial Pickleweed)		1540 ppm dry weight	Shoot - 0.75 ppm dry weight	F. Demgen 1996	
Mercury	*Salicornia virginica* (Perennial Pickleweed)		0.14-1.7 ppm dry weight	Shoots- Below detection limits of <0.012-<0.8 ppm dry weight	F. Demgen 1996	
Selenium	Alfalfa	Reduced shoot weight	1.5 ppm		Wan and others 1986	
	Alfalfa	No effect	0.5 ppm of soluble copper		Wan and others 1986	
	Triticum aestivum (wheat)	Decrease in biomass. Decrease in grain yield.	2.5 ppm		Singh and Singh (1978)	
	Alfalfa	Reduced shoot weight	4.0 ppm		Soltanpour and Workman (1980)	
	Sorghum vulgare (sorgrass)	Reduced shoot weight	1.0 ppm		Carlson and others (1991)	Loamy sand soil, pH 5.5 -Se (VI) as Na_2SeO_4
	Sorghum vulgare (sorgrass)	No effect	4.0 ppm		Carlson and others (1991)	Loamy sand soil, pH 6.0 - Se (IV) as Na_2SeO_3
	Sorghum vulgare (sorgrass)	Reduced shoot weight	1.0 ppm		Carlson and others (1991)	Sandy soil, pH 4.9 -Se (VI) as Na_2SeO_4
	Sorghum vulgare (sorgrass)	Reduced shoot weight	2.0 ppm		Carlson and others (1991)	Sandy soil, pH 4.9 - Se (IV) as Na_2SeO_3

TABLE 71 (Continued)

SUMMARY OF ECOLOGICAL EFFECTS OF METALS ON PLANTS
FIVE YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Kind of Plant	Effects	Concentration in Soil	Concentration in Tissue	Reference	Other Comments
Zinc	*Typha latifolia* (cattail)	Reduced shoot and root biomass (compared to plants grown in soil with 13 ppm)	5,000 ppm		S.J. McNaughton and others 1974	No indication that *T. latifolia* has evolved resistant genotypes on heavy metal soils
	Festuca ovina		20,616 ppm	Aerial green parts - 197.0 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Agrostis tenuis		20,616 ppm	Aerial green parts - 169.4 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Armeria maritima		20,616 ppm	Aerial green parts - 395.7 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Viola calaminaria		20,616 ppm	Aerial green parts - 117.0 ppm dry weight	E. Simon 1978	Capable of developing a metal tolerance. Plants sampled from "Pioneer Turf". Pioneer turf consists of blast furnace slags mixed with soil.
	Lolium perenne (perennial ryegrass)	No effect on yield	165 ppm		W. Dijkshoorn 1981	Acidification of soil contaminated with metalliferous sewage sludge increases the uptake of polluting metals

Note: Shaded rows indicate effects for wetland plants
ppm Part per million

TABLE 72

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Arsenic	1	MHRSS001	1	1.5	4.20	0.00	0.05
		MHRSS001	0	0.5	5.10	0.01	0.12
		MHRSS002	1	1.5	4.50	0.06	1.23
		MHRSS002	0	0.5	4.90	0.02	0.47
		MHRSS003	1	1.5	26.50	0.02	0.09
		MHRSS003	0	0.5	14.50	0.10	0.69
		MHRSS004	1	1.5	20.60	0.00	0.02
		MHRSS004	0	0.5	5.60	0.00	0.05
		MHRSS005	1	1.5	13.60	0.11	0.77
		MHRSS005	0	0.5	11.00	0.08	0.75
	2	R01SS017	1	1.5	19.20	0.20	1.02
		R01SS017	0	0.5	44.90	0.09	0.21
	3	R01DH019	1	1.5	4.90	0.00	0.06
		R01DH019	0	0.5	16.70	0.00	0.03
		R01DH030	1	1.5	21.40	0.01	0.06
		R01DH030	0	0.5	4.40	0.00	0.07
	4	R01SS104	1	1.5	40.80	0.51	1.24
		R01SS104	0	0.5	36.00	0.44	1.23
	5	R01DH117	1	1.5	4.40	0.02	0.50
		R01DH117	0	0.5	21.80	0.06	0.26
	6	R01SS078	1	1.5	410.00	1.31	0.32
		R01SS078	0	0.5	759.00	1.42	0.19
		R01SS084	0	0.5	632.00	1.76	0.28
		R01SS091	0	0.5	1050.00	2.74	0.26
		R01SS108	0	0.5	1250.00	0.85	0.07
		R01SS138	0	0.5	21.80	0.03	0.12
		R01SS143	0	0.5	10.20	0.05	0.46
	9	R01SH023	1	1.5	9.30	0.15	1.59
		R01SH023	0	0.5	18.80	0.00	0.02
		R01SH028	1	1.5	13.90	0.02	0.12
		R01SH029	1	1.5	15.10	0.13	0.83
		R01SH029	0	0.5	93.70	0.71	0.76
		R01SH033	1	1.5	7.10	0.03	0.36
		R01SH033	0	0.5	20.80	0.03	0.16
		R01SH043	1	1.5	9.70	0.11	1.12
		R01SH043	0	0.5	14.80	0.01	0.06
	10	R01SH074	1	1.5	60.70	0.55	0.91
		R01SH074	0	0.5	103.00	0.49	0.48
		R01SH075	1	1.5	45.00	0.14	0.32
		R01SH075	0	0.5	59.30	0.05	0.08
		R01SH118	1	1.5	45.00	0.26	0.58
		R01SH118	0	0.5	54.90	0.57	1.03
		R01SH131	1	1.5	74.60	0.27	0.36
		R01SH131	0	0.5	35.30	0.43	1.23
		R01SH134	1	1.5	21.40	0.18	0.84
		R01SH134	0	0.5	70.50	1.16	1.65
	11	R01SH082	1	1.5	37.40	0.13	0.34
		R01SH082	0	0.5	50.20	0.59	1.17
		R01SH097	1	1.5	16.00	0.09	0.57
		R01SH097	0	0.5	30.00	0.35	1.16
	12	R03SS171	0	0.5	10.80	0.01	0.05
		R03SS174	1	1.5	3.40	0.00	0.06
		R03SS174	0	0.5	5.10	0.01	0.20
		R03SS178	0	0.5	5.70	0.00	0.07

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Arsenic (Continued)	13	R03WD153	1	1.5	9.00	0.01	0.07
		R03WD153	0	0.5	7.80	0.01	0.07
		R03WD154	1	1.5	8.20	0.01	0.06
		R03WD156	1	1.5	9.70	0.00	0.04
		R03WD156	0	0.5	10.90	0.00	0.03
Cadmium	1	MHRSS001	1	1.5	no data	0.00	--
		MHRSS001	0	0.5	no data	0.00	--
		MHRSS002	1	1.5	0.07	0.00	1.04
		MHRSS002	0	0.5	0.05	0.00	2.60
		MHRSS003	1	1.5	0.16	0.00	0.19
		MHRSS003	0	0.5	0.09	0.00	0.33
		MHRSS004	1	1.5	0.08	0.00	0.35
		MHRSS004	0	0.5	0.05	0.00	0.40
		MHRSS005	1	1.5	0.10	0.00	1.00
		MHRSS005	0	0.5	0.17	0.00	0.18
	2	R01SS017	1	1.5	0.11	0.00	3.09
		R01SS017	0	0.5	0.12	0.00	3.00
	3	R01DH019	1	1.5	0.34	0.00	0.06
		R01DH019	0	0.5	2.10	0.00	0.10
		R01DH030	1	1.5	1.60	0.00	0.16
		R01DH030	0	0.5	0.23	0.00	0.09
	4	R01SS104	1	1.5	1.10	0.02	1.73
		R01SS104	0	0.5	0.53	0.00	0.19
	5	R01DH117	1	1.5	0.44	0.00	0.36
		R01DH117	0	0.5	1.50	0.01	0.61
	6	R01SS078	1	1.5	0.70	0.01	1.70
		R01SS078	0	0.5	0.21	0.00	1.38
		R01SS084	0	0.5	0.16	0.00	1.25
		R01SS091	0	0.5	0.19	0.00	1.84
		R01SS108	0	0.5	0.66	0.00	0.59
		R01SS138	0	0.5	1.50	0.00	0.03
		R01SS143	0	0.5	0.58	0.00	0.55
	9	R01SH023	1	1.5	0.44	0.02	3.98
		R01SH023	0	0.5	0.69	0.00	0.32
		R01SH028	1	1.5	0.10	0.00	0.20
		R01SH029	1	1.5	0.11	0.00	0.52
		R01SH029	0	0.5	0.30	0.01	3.80
		R01SH033	1	1.5	0.09	0.00	0.22
		R01SH033	0	0.5	0.26	0.00	0.30
		R01SH043	1	1.5	0.75	0.03	3.44
		R01SH043	0	0.5	no data	0.00	--
	10	R01SH074	1	1.5	6.50	0.05	0.72
		R01SH074	0	0.5	63.40	0.02	0.04
		R01SH075	1	1.5	5.90	0.02	0.34
		R01SH075	0	0.5	63.80	0.00	0.00
		R01SH118	1	1.5	3.10	0.02	0.79
		R01SH118	0	0.5	7.60	0.13	1.70
		R01SH131	1	1.5	9.80	0.03	0.31
		R01SH131	0	0.5	4.00	0.10	2.49
		R01SH134	1	1.5	0.76	0.01	1.01
		R01SH134	0	0.5	7.20	0.29	4.01
	11	R01SH082	1	1.5	8.70	0.04	0.50
		R01SH082	0	0.5	13.90	0.18	1.29
		R01SH097	1	1.5	0.67	0.02	2.37
		R01SH097	0	0.5	7.50	0.16	2.17

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Cadmium (Continued)	12	R03SS171	0	0.5	0.61	0.02	2.92
		R03SS174	1	1.5	no data	0.00	--
		R03SS174	0	0.5	no data	0.00	--
		R03SS178	0	0.5	0.04	0.00	0.93
	13	R03WD153	1	1.5	0.33	0.00	0.19
		R03WD153	0	0.5	6.90	0.00	0.02
		R03WD154	1	1.5	0.07	0.00	0.70
		R03WD156	1	1.5	0.71	0.00	0.10
		R03WD156	0	0.5	1.90	0.00	0.07
Copper	1	MHRSS001	1	1.5	9.10	0.02	0.17
		MHRSS001	0	0.5	9.70	0.07	0.73
		MHRSS002	1	1.5	6.40	0.23	3.66
		MHRSS002	0	0.5	8.40	0.10	1.19
		MHRSS003	1	1.5	60.40	0.27	0.45
		MHRSS003	0	0.5	57.40	0.78	1.36
		MHRSS004	1	1.5	55.20	0.01	0.02
		MHRSS004	0	0.5	9.70	0.00	0.05
		MHRSS005	1	1.5	45.00	0.23	0.51
		MHRSS005	0	0.5	44.90	0.70	1.55
	2	R01SS017	1	1.5	62.20	0.40	0.65
		R01SS017	0	0.5	72.80	0.41	0.56
	3	R01DH019	1	1.5	16.20	0.01	0.05
		R01DH019	0	0.5	83.70	0.06	0.07
		R01DH030	1	1.5	82.60	0.02	0.02
		R01DH030	0	0.5	11.20	0.01	0.07
	4	R01SS104	1	1.5	59.10	0.68	1.14
		R01SS104	0	0.5	140.00	1.91	1.36
	5	R01DH117	1	1.5	25.00	0.11	0.44
		R01DH117	0	0.5	21.40	0.02	0.08
	6	R01SS078	1	1.5	204.00	0.09	0.05
		R01SS078	0	0.5	310.00	0.52	0.17
		R01SS084	0	0.5	441.00	2.24	0.51
		R01SS091	0	0.5	306.00	3.08	1.01
		R01SS108	0	0.5	627.00	0.82	0.13
		R01SS138	0	0.5	117.00	0.04	0.03
		R01SS143	0	0.5	128.00	0.15	0.12
	9	R01SH023	1	1.5	18.90	0.36	1.89
		R01SH023	0	0.5	85.20	0.00	0.00
		R01SH028	1	1.5	38.20	0.02	0.05
		R01SH029	1	1.5	51.40	0.45	0.87
		R01SH029	0	0.5	76.10	0.74	0.97
		R01SH033	1	1.5	31.70	0.02	0.08
		R01SH033	0	0.5	77.90	0.09	0.11
		R01SH043	1	1.5	36.90	0.27	0.73
		R01SH043	0	0.5	73.40	0.03	0.05
	10	R01SH074	1	1.5	172.00	1.01	0.59
		R01SH074	0	0.5	291.00	0.99	0.34
		R01SH075	1	1.5	84.30	0.07	0.08
		R01SH075	0	0.5	258.00	0.02	0.01
		R01SH118	1	1.5	152.00	0.63	0.41
		R01SH118	0	0.5	129.00	1.43	1.11
		R01SH131	1	1.5	149.00	0.25	0.17
		R01SH131	0	0.5	586.00	7.84	1.34
		R01SH134	1	1.5	42.20	0.27	0.65
		R01SH134	0	0.5	284.00	1.20	0.42

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Copper (Continued)	11	R01SH082	1	1.5	75.20	0.10	0.14
		R01SH082	0	0.5	137.00	0.97	0.71
		R01SH097	1	1.5	30.40	0.28	0.92
		R01SH097	0	0.5	61.40	0.76	1.24
	12	R03SS171	0	0.5	44.50	0.24	0.54
		R03SS174	1	1.5	14.70	0.01	0.05
		R03SS174	0	0.5	19.10	0.14	0.73
		R03SS178	0	0.5	20.00	0.01	0.03
	13	R03WD153	1	1.5	38.90	0.01	0.03
		R03WD153	0	0.5	28.10	0.03	0.11
		R03WD154	1	1.5	40.00	0.18	0.44
		R03WD156	1	1.5	36.80	0.01	0.04
		R03WD156	0	0.5	49.00	0.02	0.04
Lead	1	MHRSS001	1	1.5	4.40	0.00	0.06
		MHRSS001	0	0.5	7.50	0.07	0.87
		MHRSS002	1	1.5	3.80	0.12	3.11
		MHRSS002	0	0.5	14.10	0.13	0.94
		MHRSS003	1	1.5	28.70	0.17	0.57
		MHRSS003	0	0.5	58.10	1.09	1.88
		MHRSS004	1	1.5	33.50	0.00	0.01
		MHRSS004	0	0.5	8.50	0.00	0.04
		MHRSS005	1	1.5	17.10	0.15	0.87
		MHRSS005	0	0.5	29.90	0.76	2.55
	2	R01SS017	1	1.5	22.20	0.37	1.67
		R01SS017	0	0.5	96.40	0.62	0.64
	3	R01DH019	1	1.5	4.60	0.00	0.04
		R01DH019	0	0.5	38.40	0.02	0.04
		R01DH030	1	1.5	56.40	0.01	0.02
		R01DH030	0	0.5	2.50	0.00	0.20
	4	R01SS104	1	1.5	35.30	0.67	1.90
		R01SS104	0	0.5	80.80	1.73	2.14
	5	R01DH117	1	1.5	5.30	0.04	0.82
		R01DH117	0	0.5	10.50	0.04	0.39
	6	R01SS078	1	1.5	69.90	0.03	0.04
		R01SS078	0	0.5	123.00	0.02	0.01
		R01SS084	0	0.5	140.00	0.37	0.26
		R01SS091	0	0.5	132.00	0.13	0.10
		R01SS108	0	0.5	182.00	0.06	0.03
		R01SS138	0	0.5	99.60	0.00	0.00
		R01SS143	0	0.5	37.30	0.01	0.02
	9	R01SH023	1	1.5	6.60	0.24	3.56
		R01SH023	0	0.5	31.60	0.01	0.03
		R01SH028	1	1.5	11.00	0.01	0.05
		R01SH029	1	1.5	13.20	0.24	1.80
		R01SH029	0	0.5	34.10	0.59	1.72
		R01SH033	1	1.5	12.60	0.01	0.06
		R01SH033	0	0.5	33.30	0.03	0.08
		R01SH043	1	1.5	13.80	0.23	1.64
		R01SH043	0	0.5	28.30	0.04	0.13

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Lead (Continued)	10	R01SH074	1	1.5	65.20	0.78	1.19
		R01SH074	0	0.5	62.70	0.46	0.74
		R01SH075	1	1.5	25.30	0.03	0.11
		R01SH075	0	0.5	73.30	0.00	0.01
		R01SH118	1	1.5	36.20	0.39	1.07
		R01SH118	0	0.5	59.40	0.79	1.32
		R01SH131	1	1.5	61.00	0.22	0.37
		R01SH131	0	0.5	231.00	5.23	2.26
		R01SH134	1	1.5	10.60	0.16	1.50
		R01SH134	0	0.5	109.00	2.22	2.04
	11	R01SH082	1	1.5	24.60	0.12	0.48
		R01SH082	0	0.5	49.10	0.73	1.48
		R01SH097	1	1.5	7.10	0.11	1.55
		R01SH097	0	0.5	22.20	0.46	2.05
	12	R03SS171	0	0.5	28.60	0.09	0.33
		R03SS174	1	1.5	7.40	0.00	0.06
		R03SS174	0	0.5	8.70	0.26	3.03
		R03SS178	0	0.5	27.10	0.00	0.01
	13	R03WD153	1	1.5	10.90	0.01	0.08
		R03WD153	0	0.5	17.50	0.02	0.11
		R03WD154	1	1.5	11.70	0.02	0.20
		R03WD156	1	1.5	11.90	0.01	0.07
		R03WD156	0	0.5	33.20	0.01	0.04
Mercury	1	MHRSS001	1	1.5	0.01	0.00	0.40
		MHRSS001	0	0.5	0.01	0.00	0.20
		MHRSS002	1	1.5	0.02	0.00	1.70
		MHRSS002	0	0.5	0.04	0.00	0.10
		MHRSS003	1	1.5	0.40	0.00	0.01
		MHRSS003	0	0.5	0.34	0.00	0.02
		MHRSS004	1	1.5	0.34	0.00	0.03
		MHRSS004	0	0.5	0.06	0.00	0.17
		MHRSS005	1	1.5	0.27	0.00	0.06
		MHRSS005	0	0.5	0.25	0.00	0.03
	2	R01SS017	1	1.5	0.33	0.00	0.02
		R01SS017	0	0.5	0.30	0.00	0.03
	3	R01DH019	1	1.5	0.22	0.00	0.04
		R01DH019	0	0.5	0.30	0.00	0.03
		R01DH030	1	1.5	0.19	0.00	0.05
		R01DH030	0	0.5	0.16	0.00	0.06
	4	R01SS104	1	1.5	0.30	0.00	0.05
		R01SS104	0	0.5	0.53	0.00	0.02
	5	R01DH117	1	1.5	0.19	0.00	0.04
		R01DH117	0	0.5	0.26	0.00	0.03
	6	R01SS078	1	1.5	0.13	0.00	0.02
		R01SS078	0	0.5	0.32	0.00	0.03
		R01SS084	0	0.5	0.16	0.00	0.05
		R01SS091	0	0.5	0.27	0.00	0.02
		R01SS108	0	0.5	0.51	0.00	0.01
		R01SS138	0	0.5	0.08	0.00	0.03
		R01SS143	0	0.5	0.06	0.00	0.03

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Mercury (Continued)	9	R01SH023	1	1.5	0.36	0.00	0.01
		R01SH023	0	0.5	0.37	0.00	0.01
		R01SH028	1	1.5	0.13	0.00	0.11
		R01SH029	1	1.5	0.28	0.00	0.04
		R01SH029	0	0.5	0.71	0.00	0.01
		R01SH033	1	1.5	0.11	0.00	0.09
		R01SH033	0	0.5	0.87	0.00	0.04
		R01SH043	1	1.5	0.18	0.00	0.02
		R01SH043	0	0.5	0.37	0.00	0.01
	10	R01SH074	1	1.5	0.46	0.00	0.01
		R01SH074	0	0.5	0.67	0.00	0.01
		R01SH075	1	1.5	0.44	0.00	0.02
		R01SH075	0	0.5	0.49	0.00	0.02
		R01SH118	1	1.5	0.34	0.00	0.01
		R01SH118	0	0.5	0.40	0.00	0.01
		R01SH131	1	1.5	0.49	0.00	0.00
		R01SH131	0	0.5	0.35	0.00	0.01
		R01SH134	1	1.5	0.13	0.00	0.06
		R01SH134	0	0.5	0.53	0.00	0.02
	11	R01SH082	1	1.5	0.29	0.00	0.01
		R01SH082	0	0.5	0.35	0.00	0.01
		R01SH097	1	1.5	0.09	0.00	0.02
		R01SH097	0	0.5	0.28	0.00	0.02
	12	R03SS171	0	0.5	0.08	0.00	0.10
		R03SS174	1	1.5	0.02	0.00	0.20
		R03SS174	0	0.5	0.02	0.00	1.90
		R03SS178	0	0.5	0.05	0.00	0.16
	13	R03WD153	1	1.5	0.15	0.00	0.06
		R03WD153	0	0.5	0.05	0.00	0.16
		R03WD154	1	1.5	0.09	0.00	0.09
		R03WD156	1	1.5	0.07	0.00	0.11
		R03WD156	0	0.5	0.09	0.00	0.16
Selenium	1	MHRSS001	1	1.5	0.66	0.00	0.56
		MHRSS001	0	0.5	0.58	0.00	0.64
		MHRSS002	1	1.5	0.82	0.00	0.45
		MHRSS002	0	0.5	0.64	0.00	0.58
		MHRSS003	1	1.5	2.00	0.00	0.19
		MHRSS003	0	0.5	1.60	0.00	0.23
		MHRSS004	1	1.5	1.60	0.00	0.26
		MHRSS004	0	0.5	0.89	0.00	0.44
		MHRSS005	1	1.5	1.20	0.00	0.31
		MHRSS005	0	0.5	2.10	0.00	0.18
	2	R01SS017	1	1.5	2.30	0.00	0.13
		R01SS017	0	0.5	4.70	0.00	0.09
	3	R01DH019	1	1.5	3.00	0.00	0.10
		R01DH019	0	0.5	2.80	0.00	0.11
		R01DH030	1	1.5	2.90	0.00	0.10
		R01DH030	0	0.5	2.50	0.00	0.12
	4	R01SS104	1	1.5	2.00	0.00	0.19
		R01SS104	0	0.5	2.60	0.00	0.16
	5	R01DH117	1	1.5	2.30	0.00	0.13
		R01DH117	0	0.5	3.80	0.00	0.08

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Selenium (Continued)	6	R01SS078	1	1.5	3.40	0.00	0.11
		R01SS078	0	0.5	2.60	0.00	0.14
		R01SS084	0	0.5	3.10	0.00	0.10
		R01SS091	0	0.5	3.50	0.00	0.11
		R01SS108	0	0.5	8.90	0.00	0.04
		R01SS138	0	0.5	1.00	0.00	0.37
		R01SS143	0	0.5	1.20	0.00	0.31
	9	R01SH023	1	1.5	2.40	0.00	0.15
		R01SH023	0	0.5	1.70	0.00	0.22
		R01SH028	1	1.5	1.90	0.00	0.21
		R01SH029	1	1.5	1.30	0.00	0.28
		R01SH029	0	0.5	1.40	0.00	0.26
		R01SH033	1	1.5	1.70	0.00	0.23
		R01SH033	0	0.5	2.10	0.00	0.19
		R01SH043	1	1.5	2.90	0.00	0.13
		R01SH043	0	0.5	2.10	0.00	0.18
	10	R01SH074	1	1.5	2.10	0.01	0.29
		R01SH074	0	0.5	3.10	0.01	0.17
		R01SH075	1	1.5	0.94	0.00	0.32
		R01SH075	0	0.5	2.10	0.00	0.14
		R01SH118	1	1.5	1.80	0.00	0.21
		R01SH118	0	0.5	2.50	0.01	0.22
		R01SH131	1	1.5	2.50	0.00	0.15
		R01SH131	0	0.5	2.70	0.01	0.47
		R01SH134	1	1.5	1.60	0.00	0.19
		R01SH134	0	0.5	1.20	0.00	0.25
	11	R01SH082	1	1.5	1.40	0.00	0.26
		R01SH082	0	0.5	2.50	0.00	0.15
		R01SH097	1	1.5	2.30	0.00	0.16
		R01SH097	0	0.5	2.00	0.00	0.19
	12	R03SS171	0	0.5	0.58	0.00	0.52
		R03SS174	1	1.5	0.82	0.00	0.45
		R03SS174	0	0.5	1.10	0.00	0.34
		R03SS178	0	0.5	0.60	0.00	0.50
	13	R03WD153	1	1.5	1.40	0.00	0.21
		R03WD153	0	0.5	0.74	0.00	0.41
		R03WD154	1	1.5	1.30	0.00	0.23
		R03WD156	1	1.5	2.80	0.00	0.11
		R03WD156	0	0.5	1.00	0.00	0.30
Zinc	1	MHRSS001	1	1.5	36.70	0.26	0.70
		MHRSS001	0	0.5	38.50	0.30	0.77
		MHRSS002	1	1.5	32.20	0.69	2.15
		MHRSS002	0	0.5	43.70	0.26	0.60
		MHRSS003	1	1.5	74.70	0.28	0.37
		MHRSS003	0	0.5	111.00	0.63	0.57
		MHRSS004	1	1.5	107.00	0.03	0.03
		MHRSS004	0	0.5	58.30	0.02	0.04
		MHRSS005	1	1.5	65.40	0.41	0.63
		MHRSS005	0	0.5	104.00	0.80	0.77
	2	R01SS017	1	1.5	74.50	0.85	1.14
		R01SS017	0	0.5	164.00	1.24	0.76
	3	R01DH019	1	1.5	31.80	0.82	2.58
		R01DH019	0	0.5	385.00	1.29	0.34
		R01DH030	1	1.5	401.00	1.23	0.31
		R01DH030	0	0.5	22.90	1.01	4.41

TABLE 72 (Continued)

WASTE EXTRACTION TEST RESULTS FOR DEIONIZED WATER COMPARED WITH BULK SEDIMENT CONCENTRATONS OF METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Top Depth (ft. bgs)	Bottom Depth (ft. bgs)	Bulk Sediment (mg/kg)	WET-DI (mg/L)	(WET-DI /Bulk) x 100 (%)
Zinc (Continued)	4	R01SS104	1	1.5	200.00	3.56	1.78
		R01SS104	0	0.5	204.00	1.26	0.62
	5	R01DH117	1	1.5	44.00	0.79	1.79
		R01DH117	0	0.5	259.00	3.32	1.28
	6	R01SS078	1	1.5	348.00	2.47	0.71
		R01SS078	0	0.5	310.00	2.47	0.80
		R01SS084	0	0.5	560.00	2.52	0.45
		R01SS091	0	0.5	209.00	1.60	0.77
		R01SS108	0	0.5	469.00	2.35	0.50
		R01SS138	0	0.5	413.00	1.01	0.24
		R01SS143	0	0.5	245.00	1.54	0.63
	9	R01SH023	1	1.5	113.00	3.90	3.45
		R01SH023	0	0.5	305.00	0.75	0.25
		R01SH028	1	1.5	98.40	0.02	0.02
		R01SH029	1	1.5	76.30	0.94	1.23
		R01SH029	0	0.5	260.00	3.45	1.33
		R01SH033	1	1.5	123.00	0.02	0.02
		R01SH033	0	0.5	367.00	0.15	0.04
		R01SH043	1	1.5	285.00	5.07	1.78
		R01SH043	0	0.5	214.00	0.42	0.20
	10	R01SH074	1	1.5	1900.00	14.40	0.76
		R01SH074	0	0.5	2460.00	7.32	0.30
		R01SH075	1	1.5	907.00	5.13	0.57
		R01SH075	0	0.5	6140.00	1.77	0.03
		R01SH118	1	1.5	1250.00	7.50	0.60
		R01SH118	0	0.5	1330.00	21.90	1.65
		R01SH131	1	1.5	2500.00	10.80	0.43
		R01SH131	0	0.5	5750.00	86.20	1.50
		R01SH134	1	1.5	111.00	2.06	1.86
		R01SH134	0	0.5	3740.00	65.50	1.75
	11	R01SH082	1	1.5	1390.00	6.93	0.50
		R01SH082	0	0.5	2920.00	37.50	1.28
		R01SH097	1	1.5	94.90	4.86	5.12
		R01SH097	0	0.5	1780.00	46.20	2.60
	12	R03SS171	0	0.5	118.00	2.30	1.95
		R03SS174	1	1.5	32.60	0.07	0.23
		R03SS174	0	0.5	57.50	1.85	3.22
		R03SS178	0	0.5	92.00	0.66	0.71
	13	R03WD153	1	1.5	1450.00	2.65	0.18
		R03WD153	0	0.5	2490.00	2.38	0.10
		R03WD154	1	1.5	233.00	1.33	0.57
		R03WD156	1	1.5	1030.00	2.91	0.28
		R03WD156	0	0.5	1840.00	2.65	0.14

Notes:

bgs	Below ground surface
ft	Feet
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
WET-DI	Waste extraction test, using deionized water as an extraction solvent

TABLE 73

COMPARISON OF POREWATER EXTRACTION AND BULK-SEDIMENT CONCENTRATIONS OF METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Surface (0.0 - 0.5 foot bgs)		
			Bulk Sediment (mg/kg)	Porewater Concentration (mg/L)	(Porewater / Bulk) x 100 (%)
Arsenic	9	R01SH023	18.8	0.0158	0.0840
		R01SH028	94.2	0.153	0.1624
		R01SH029	93.7	0.0736	0.0785
	10	R01SH074	103	0.0293	0.0284
		R01SH118	54.9	0.0568	0.1035
		R01SH131	35.3	0.0104	0.0295
		R01SH134	70.5	0.028	0.0397
	11	R01SH082	50.2	0.0086	0.0171
	13	R03WD154	7.6	0.0053	0.0697
		R03WD156	10.9	0.0046	0.0422
Cadmium	9	R01SH023	0.69	0.0003	0.0435
		R01SH028	1	0.0002	0.0200
		R01SH029	0.3	0.00058	0.1933
	10	R01SH074	63.4	0.0003	0.0005
		R01SH118	7.6	0.0003	0.0039
		R01SH131	4	0.0003	0.0075
		R01SH134	7.2	0.00033	0.0046
	11	R01SH082	13.9	0.0003	0.0022
	13	R03WD154	3.8	0.00042	0.0111
		R03WD156	1.9	0.00067	0.0353
Copper	9	R01SH023	85.2	0.00089	0.0010
		R01SH028	84.8	0.0011	0.0013
		R01SH029	76.1	0.0583	0.0766
	10	R01SH074	291	0.0072	0.0025
		R01SH118	129	0.0159	0.0123
		R01SH131	586	0.0018	0.0003
		R01SH134	284	0.0228	0.0080
	11	R01SH082	137	0.0054	0.0039
	13	R03WD154	34.5	0.0011	0.0032
		R03WD156	49	0.0065	0.0133
Lead	9	R01SH023	31.6	0.0015	0.0047
		R01SH028	33.9	0.0017	0.0050
		R01SH029	34.1	0.0117	0.0343
	10	R01SH074	62.7	0.0015	0.0024
		R01SH118	59.4	0.0015	0.0025
		R01SH131	231	0.0015	0.0006
		R01SH134	109	0.0241	0.0221
	11	R01SH082	49.1	0.0015	0.0031
	13	R03WD154	38	0.0022	0.0058
		R03WD156	33.2	0.0017	0.0051

TABLE 73 (Continued)

COMPARISON OF POREWATER EXTRACTION AND BULK-SEDIMENT CONCENTRATIONS OF METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Surface (0.0 - 0.5 foot bgs)		
			Bulk Sediment (mg/kg)	Porewater Concentration (mg/L)	(Porewater / Bulk) x 100 (%)
Mercury	9	R01SH023	0.37	0.00005	0.0135
		R01SH028	0.5	0.00008	0.0160
		R01SH029	0.71	0.00031	0.0437
	10	R01SH074	0.67	0.00005	0.0075
		R01SH118	0.4	0.0001	0.0250
		R01SH131	0.35	0.00002	0.0057
		R01SH134	0.53	0.00011	0.0208
	11	R01SH082	0.35	0.00007	0.0200
	13	R03WD154	0.06	0.00012	0.2000
		R03WD156	0.09	0.00008	0.0889
Selenium	9	R01SH023	1.7	0.0037	0.2176
		R01SH028	1.5	0.003	0.2000
		R01SH029	1.4	0.0037	0.2643
	10	R01SH074	3.1	0.0037	0.1194
		R01SH118	2.5	0.0037	0.1480
		R01SH131	2.7	0.0037	0.1370
		R01SH134	1.2	0.003	0.2500
	11	R01SH082	2.5	0.0037	0.1480
	13	R03WD154	1.5	0.003	0.2000
		R03WD156	1	0.003	0.3000
Zinc	9	R01SH023	305	0.017	0.0056
		R01SH028	386	0.0155	0.0040
		R01SH029	260	0.0787	0.0303
	10	R01SH074	2,460	0.0313	0.0013
		R01SH118	1,330	0.0521	0.0039
		R01SH131	5,750	0.0107	0.0002
		R01SH134	3,740	0.195	0.0052
	11	R01SH082	2,920	0.0846	0.0029
	13	R03WD154	2,190	0.111	0.0051
		R03WD156	1,840	0.107	0.0058

Notes:

%	Percent
bgs	Below ground surface
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter

TABLE 74

**BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM THE QUALITATIVE ECOLOGICAL ASSESSMENT
AND OCTOBER 2000 FOR SIX METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA**

Location	Spatial Unit	Analyte	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with 1/2 Detection Limit Value[c]
R01SH074[d]	10	Arsenic	103	14.1	0.14	0.14
R01SH118[d]	10	Arsenic	54.9	10.3	0.19	0.19
R01SH118[e]	10	Arsenic	34.8 J	8.2 J	0.24	0.24
R01SH131[d]	10	Arsenic	35.3	9.74	0.28	0.28
R01SH306[e]	11	Arsenic	46.4 J	21.4	0.46	0.46
R01SH305[e]	11	Arsenic	49.2 J	19.8	0.40	0.40
R01SH254[e]	11	Arsenic	71.4 J	22.4	0.31	0.31
SLRSH01[e] (Reference site)	**--**	**Arsenic**	**13.2 J**	**15.1 J**	**1.14**	**1.14**
SLRSH02[e] (Reference site)	--	Arsenic	24.5 J	13 J	0.53	0.53
SLRSH03[e] (Reference site)	--	Arsenic	17.2 J	7.4 U	0.43	0.22
R01SH074[d]	10	Cadmium	63.4	2.58	0.04	0.04
R01SH118[d]	10	Cadmium	7.6	2.86	0.38	0.38
R01SH118[e]	10	Cadmium	4.3 J	2 J	0.47	0.47
R01SH131[d]	10	Cadmium	4	2.44	0.61	0.61
R01SH306[e]	11	Cadmium	6.8	2.4 J	0.35	0.35
R01SH305[e]	11	Cadmium	5.6 J	4.2 J	0.75	0.75
R01SH254[e]	11	Cadmium	11.8 J	3.3 J	0.28	0.28
SLRSH01[e] (Reference site)	--	Cadmium	0.09 UJ	2 J	22.2	44.4
SLRSH02[e] (Reference site)	--	Cadmium	0.21 UJ	2.3 J	11.0	21.9
SLRSH03[e] (Reference site)	--	Cadmium	0.08 UJ	2.1 J	26.3	52.5
R01SH074[d]	10	Copper	291	80.3	0.28	0.28
R01SH118[d]	10	Copper	129	70	0.54	0.54
R01SH118[e]	10	Copper	96.4 J	86.1	0.89	0.89
R01SH131[d]	10	Copper	586	82.1	0.14	0.14
R01SH306[e]	11	Copper	97.2	91.8	0.94	0.94
R01SH305[e]	**11**	**Copper**	**95.7 J**	**102**	**1.07**	**1.07**

TABLE 74 (Continued)

**BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM THE QUALITATIVE ECOLOGICAL ASSESSMENT
AND OCTOBER 2000 FOR SIX METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA**

Location	Spatial Unit	Analyte	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with 1/2 Detection Limit Value[c]
R01SH254[e]	11	Copper	129 J	120	0.93	0.93
SLRSH01[e] (Reference site)	**--**	**Copper**	**74.4 J**	**122**	**1.64**	**1.64**
SLRSH02[e] (Reference site)	**--**	**Copper**	**70 J**	**86.3**	**1.23**	**1.23**
SLRSH03[e] (Reference site)	**--**	**Copper**	**59.6 J**	**92.1**	**1.55**	**1.55**
R01SH074[d]	10	Lead	62.7	0.45 UJ	0.007	0.004
R01SH118[d]	10	Lead	59.4	0.46 UJ	0.008	0.004
R01SH118[e]	10	Lead	45.3	4.4 U	0.10	0.05
R01SH131[d]	10	Lead	231	0.39 UJ	0.002	0.0008
R01SH306[e]	11	Lead	34.8	3.5 J	0.10	0.10
R01SH305[e]	11	Lead	47	6.3	0.13	0.13
R01SH254[e]	11	Lead	71.9	13.3	0.18	0.18
SLRSH01[e] (Reference site)	--	Lead	29.3	4 U	0.14	0.07
SLRSH02[e] (Reference site)	--	Lead	25.9	6.2	0.24	0.24
SLRSH03[e] (Reference site)	--	Lead	25.7	4.1 U	0.16	0.08
R01SH074[d]	10	Selenium	3.1	0.36 UJ	0.12	0.06
R01SH118[d]	10	Selenium	2.5	0.38 UJ	0.15	0.08
R01SH118[e]	10	Selenium	0.79 UJ	6.9 U	8.73	8.73
R01SH131[d]	10	Selenium	2.7	0.46 UJ	0.17	0.09
R01SH306[e]	**11**	**Selenium**	**3.7**	**6.1 J**	**1.65**	**1.65**
R01SH305[e]	11	Selenium	1	9.3 UJ	9.3	9.3
R01SH254[e]	11	Selenium	2.1	10.8 UJ	5.14	2.57
SLRSH01[e] (Reference site)	--	Selenium	0.58 UJ	9.8 UJ	16.9	16.9
SLRSH02[e] (Reference site)	--	Selenium	0.54 UJ	6.7 U	12.4	12.4
SLRSH03[e] (Reference site)	--	Selenium	0.49 UJ	6.5 U	13.3	13.3

TABLE 74 (Continued)

BIOACCUMULATION FACTORS FOR ASIATIC CLAMS BASED ON DATA FROM THE QUALITATIVE ECOLOGICAL ASSESSMENT AND OCTOBER 2000 FOR SIX METALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Location	Spatial Unit	Analyte	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with 1/2 Detection Limit Value[c]
R01SH074[d]	10	Zinc	2460	615	0.25	0.25
R01SH118[e]	10	Zinc	1040	325	0.31	0.31
R01SH118[d]	10	Zinc	1330	613	0.46	0.46
R01SH131[d]	10	Zinc	5750	656	0.11	0.11
R01SH306[e]	11	Zinc	1590	251	0.16	0.16
R01SH305[e]	11	Zinc	1990	318	0.16	0.16
R01SH254[e]	11	Zinc	2720	356	0.13	0.13
SLRSH01[e] (Reference site)	**--**	**Zinc**	**166**	**207**	**1.25**	**1.25**
SLRSH02[e] (Reference site)	--	Zinc	206	164	0.80	0.80
SLRSH03[e] (Reference site)	**--**	**Zinc**	**158**	**160**	**1.01**	**1.01**

Notes: **Bolded rows** indicate locations with detected sediment and tissue concentrations and calculated BAFs greater than 1.0.
Dashes indicate reference site.

a BAF = [Tissue concentration (mg/kg dry weight)]/[Sediment concentration (mg/kg dry weight)]

b For locations where the analyte was not detected in either sediment or tissue, the detection limit was used to calculate the BAF.

c For locations where the analyte was not detected in either sediment or tissue, half the detection limit was used to calculate the BAF.

d Sediment and tissue chemistry were obtained from the "Final Qualitative Ecological Assessment Report, Litigation Area, Naval Weapons Station Concord" dated September 2, 1997.

e Sediment and tissue chemistry results from October 2000 sampling event

BAF Bioaccumulation factor
J Estimated concentration
mg/kg Milligram per kilogram
mg/kg dw Milligram per kilogram dry weight
U Nondetect concentration (value is replaced with analytical detection limit)

TABLE 75

**BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM OCTOBER 2000 FOR OTHER METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA**

Analyte	Spatial Unit	Location	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with One-Half Detection Limit Value[c]
Aluminum	10	R01SH074[d]	42,700	307	0.007	0.007
		R01SH118[d]	32,000	253	0.008	0.008
		R01SH118[e]	26,800	1,220 J	0.05	0.05
		R01SH131[d]	49,500	151	0.003	0.003
	11	R01SH305[e]	24,600	2,270 J	0.09	0.09
		R01SH306[e]	38,800	2,680 J	0.07	0.07
		R01SH254[e]	31,800	1.160	0.04	0.04
	(Reference site)	SLRSH01[e]	40,500	1,060 J	0.03	0.03
	(Reference site)	SLRSH02[e]	29,500	578 J	0.02	0.02
	(Reference site)	SLRSH03[e]	27,500	714 J	0.03	0.03
Antimony	10	R01SH074[d]	---	0.11 U	---	---
		R01SH118[d]	2.3 U	0.1 U	0.04	0.04
		R01SH118[e]	2 UJ	10.4 U	5.20	5.2
		R01SH131[d]	2.5 U	0.1 U	0.04	0.04
	11	R01SH305[e]	2.5 UJ	10.9 U	4.36	4.36
		R01SH306[e]	4.4 UJ	11 U	2.50	2.5
		R01SH254[e]	3.6 UJ	7.1 U	1.97	1.97
	(Reference site)	SLRSH01[e]	2.4 UJ	9.5 U	3.96	3.96
	(Reference site)	SLRSH02[e]	3.8 UJ	10 U	2.63	2.63
	(Reference site)	SLRSH03[e]	1.2 UJ	9.8 U	8.17	8.17
Barium	10	R01SH074[d]	113	2.4 U	0.02	0.01
		R01SH118[d]	93.9	2.2 U	0.02	0.01
		R01SH118[e]	94.8 J	23.3 J	0.43	0.43
		R01SH131[d]	155	2.1 U	0.01	0.007
	11	R01SH305[e]	106 J	64.3 J	0.61	0.61
		R01SH306[e]	143 J	60.8 J	0.43	0.43
		R01SH254[e]	92.4 J	35.9 J	0.25	0.25
	(Reference site)	SLRSH01[e]	108	12.6 J	0.12	0.12
	(Reference site)	SLRSH02[e]	92	10.2 J	0.11	0.11
	(Reference site)	SLRSH03[e]	81.1	13.2 J	0.16	0.16

TABLE 75 (Continued)

**BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM OCTOBER 2000 FOR OTHER METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA**

Analyte	Spatial Unit	Location	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with One-Half Detection Limit Value[c]
Beryllium	10	R01SH074[d]	0.89	0.01 U	0.01	0.006
		R01SH118[d]	0.66	0.01 U	0.01	0.008
		R01SH118[e]	0.57 J	1.1 U	1.93	0.96
		R01SH131[d]	0.74	0.01 U	0.01	0.007
	11	R01SH305[e]	0.35 J	1.1 U	3.14	1.57
		R01SH306[e]	0.66 J	1.2 U	1.82	0.91
		R01SH254[e]	0.94 J	0.75 U	0.80	0.40
	(Reference site)	SLRSH01[e]	1.1 J	1 U	0.91	0.45
	(Reference site)	SLRSH02[e]	0.84 J	1.1 U	1.31	0.65
	(Reference site)	SLRSH03[e]	0.72 J	1 U	1.39	0.69
Chromium	10	R01SH074[d]	108	0.78	0.007	0.007
		R01SH118[d]	86.1	0.62	0.007	0.007
		R01SH118[e]	74.5	5.6 J	0.08	0.08
		R01SH131[d]	80.4	0.39	0.005	0.005
	11	R01SH305[e]	65.7	7 J	0.11	0.11
		R01SH306[e]	98	8.5 J	0.09	0.09
		R01SH254[e]	80.7	3.9 J	0.05	0.05
	(Reference site)	SLRSH01[e]	118	8 J	0.07	0.07
	(Reference site)	SLRSH02[e]	92.1	6.7 J	0.07	0.07
	(Reference site)	SLRSH03[e]	79	6 J	0.08	0.08
Cobalt	10	R01SH074[d]	29.1	0.23	0.008	0.008
		R01SH118[d]	22	0.21	0.01	0.01
		R01SH118[e]	17.4 J	2 U	0.11	0.06
		R01SH131[d]	13.9	0.15	0.01	0.01
	11	R01SH305[e]	19.1 J	2.1 UJ	0.11	0.06
		R01SH306[e]	29.9 J	2.1 UJ	0.07	0.04
		R01SH254[e]	16.8 J	1.4 U	0.08	0.04
	(Reference site)	SLRSH01[e]	24.8	2.2 UJ	0.09	0.04
Cobalt	(Reference site)	SLRSH02[e]	23.4	2.5 UJ	0.11	0.05
	(Reference site)	SLRSH03[e]	16.8 J	1.9 U	0.11	0.06

TABLE 75 (Continued)

BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM OCTOBER 2000 FOR OTHER METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Spatial Unit	Location	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with One-Half Detection Limit Value[c]
Manganese	10	R01SH074[d]	543	12.1	0.02	0.02
		R01SH118[d]	532	12.6 U	0.02	0.01
		R01SH118[e]	498	79.7	0.16	0.16
		R01SH131[d]	561	12.6	0.02	0.02
	11	R01SH305[e]	1,150	191	0.17	0.17
		R01SH306[e]	1,180	196	0.17	0.17
		R01SH254[e]	598	86.3	0.14	0.14
	(Reference site)	SLRSH01[e]	748	57.3	0.08	0.08
	(Reference site)	SLRSH02[e]	537	190	0.35	0.35
	(Reference site)	SLRSH03[e]	475	47	0.10	0.10
Mercury	10	R01SH074[d]	0.67	0.04 U	0.06	0.03
		R01SH118[d]	0.4	0.03 U	0.08	0.04
		R01SH118[e]	**0.26 J**	**3.7**	**14.2**	**14.2**
		R01SH131[d]	0.35	0.02 U	0.06	0.03
	11	R01SH306[e]	0.36	0.43 U	1.19	0.60
		R01SH305[e]	0.27	0.42 U	1.56	0.78
		R01SH254[e]	0.36	0.5 U	1.39	0.69
	(Reference site)	**SLRSH01[e]**	**0.28 J**	**0.66**	**2.36**	**2.36**
	(Reference site)	**SLRSH02[e]**	**0.32**	**0.93**	**2.91**	**2.91**
	(Reference site)	**SLRSH03[e]**	**0.27**	**0.44**	**1.63**	**1.63**
Molybdenum	10	R01SH074[d]	3.5	0.14	0.04	0.04
		R01SH118[d]	1.8	0.13 U	0.07	0.04
		R01SH118[e]	1.4 J	5.5 UJ	3.93	1.96
		R01SH131[d]	1.1	0.19 U	0.17	0.09
	11	R01SH305[e]	1.7 U	4.9 UJ	2.88	2.88
		R01SH306[e]	2.2 U	3.3 UJ	1.5	1.5
		R01SH254[e]	1.1 U	2.1 U	1.91	1.91
Molybdenum	(Reference site)	SLRSH01[e]	1 J	4.5 UJ	4.5	2.25
	(Reference site)	SLRSH02[e]	1.4 J	6.9 UJ	4.93	2.46
	(Reference site)	SLRSH03[e]	0.8 U	2.9 U	3.63	3.63

TABLE 75 (Continued)

**BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM OCTOBER 2000 FOR OTHER METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA**

Analyte	Spatial Unit	Location	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with One-Half Detection Limit Value[c]
Nickel	10	R01SH074[d]	102	0.83	0.008	0.008
		R01SH118[d]	84.5	0.67	0.008	0.008
		R01SH118[e]	74.9	4.4 J	0.06	0.06
		R01SH131[d]	68.1	0.51	0.007	0.007
	11	R01SH305[e]	66.4	6.7 J	0.10	0.10
		R01SH306[e]	96.1	7.7 J	0.08	0.08
		R01SH254[e]	77.4	3.5 J	0.05	0.05
	(Reference site)	SLRSH01[e]	123	4.3 J	0.03	0.03
	(Reference site)	SLRSH02[e]	97.3	5.3 J	0.05	0.05
	(Reference site)	SLRSH03[e]	77.3	1.9 U	0.02	0.01
Silver	10	R01SH074[d]	0.49 U	0.06 U	0.12	0.12
		R01SH118[d]	0.38 U	0.06 U	0.16	0.16
		R01SH118[e]	0.96 U	1.1 U	1.15	1.15
		R01SH131[d]	0.54 U	0.05 U	0.09	0.09
	11	R01SH305[e]	1.5 U	1.1 U	0.73	0.73
		R01SH306[e]	1.9 U	1.2 U	0.63	0.63
		R01SH254[e]	0.38 U	0.87 J	2.29	4.58
	(Reference site)	SLRSH01[e]	0.79 U	1.2 J	1.52	3.04
	(Reference site)	SLRSH02[e]	0.71 U	1.1 U	1.55	1.55
	(Reference site)	SLRSH03[e]	0.68 U	1 U	1.47	1.47
Thallium	10	R01SH074[d]	0.53 U	0.18 U	0.34	0.34
		R01SH118[d]	0.37 U	0.16 U	0.43	0.43
		R01SH118[e]	0.62 U	2.4 U	3.87	3.87
		R01SH131[d]	0.38 U	0.16 U	0.42	0.42
	11	R01SH305[e]	0.93 U	2.5 U	2.69	2.69
		R01SH306[e]	1.2 U	2.8 U	2.33	2.33
	11	R01SH254[e]	0.89 UJ	1.8 UJ	2.02	2.02
	(Reference site)	SLRSH01[e]	0.54 U	2.5 U	4.63	4.63
	(Reference site)	SLRSH02[e]	0.5 U	2.8 U	5.6	5.6
	(Reference site)	SLRSH03[e]	0.45 U	2.3 U	5.11	5.11

TABLE 75 (Continued)

**BIOACCUMULATION FACTORS FOR ASIATIC CLAMS
BASED ON DATA FROM OCTOBER 2000 FOR OTHER METALS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA**

Analyte	Spatial Unit	Location	Bulk Sediment Concentration (mg/kg dw)	Tissue Concentration (mg/kg dw)	BAF[a] Calculated with Full Detection Limit Value[b]	BAF Calculated with One-Half Detection Limit Value[c]
Vanadium	10	R01SH074[d]	123	0.98	0.008	0.008
		R01SH118[d]	97.8	0.83	0.008	0.008
		R01SH118[e]	80.2	5.3 UJ	0.07	0.03
		R01SH131[d]	82.5	0.59	0.007	0.007
	11	R01SH305[e]	78	9.5 J	0.12	0.12
		R01SH306[e]	109	9.3 J	0.09	0.09
		R01SH254[e]	84.1	6.2 J	0.07	0.07
	(Reference site)	SLRSH01[e]	116	5 UJ	0.04	0.02
	(Reference site)	SLRSH02[e]	106	4.4 UJ	0.04	0.02
	(Reference site)	SLRSH03[e]	140	3.1 UJ	0.02	0.01

Notes: **Bold** rows indicate locations with detected sediment and tissue concentrations and calculated BAFs greater than 1.0.

a BAF = [Tissue concentration (mg/kg dry weight)]/[Sediment concentration (mg/kg dry weight)].

b For locations where analyte was not detected in either sediment or tissue, the detection limit was used to calculate the BAF.

c For locations where analyte was not detected in either sediment or tissue, half the detection limit was used to calculate the BAF.

d Sediment and tissue chemistry were obtained from "Final Qualitative Ecological Assessment Report, Litigation Area, Naval Weapons Station Concord," dated September 2, 1997.

e Sediment and tissue chemistry results from October 2000 sampling event.

BAF Bioaccumulation factor

mg/kg dw Milligram per kilogram dry weight

J Estimated concentration

U Nondetect concentration (value is replaced with analytical detection limit)

--- Not applicable

TABLE 76

TISSUE CONCENTRATIONS OF METALS AND BIOACCUMULATION FACTORS FOR VERTEBRATE AND OTHER INVERTEBRATE RECEPTORS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Metal	Location	Tissue Type	[Tissue][a] (mg/kg)	[Sediment][b] (mg/kg)	[Tissue] / [Sediment]
Arsenic	R01SH074	Sculpin	ND	93.5	*
	R01SH118	Sculpin	ND	93.5	*
	R01SH131	Sculpin	1.3	93.5	0.0139
	R03WD153	Stickleback	1.45	11.5	0.126
	R03WD155	Stickleback	0.88	11.5	0.077
	R03WD153	Tadpole	5.65	11.5	0.491
	R01SH074	Amphipods	6.41	103	0.0622
	R01SH118	Amphipods	8.27	54.9	0.151
	R01SH131	Amphipods	4.24	35.3	0.120
	RASS 3 Pond	Crayfish	2.97	11.5	0.258
	RASS 3 Pond	Damselfly Larva	ND	11.5	*
Beryllium	R01SH074	Sculpin	ND	0.39	*
	R01SH118	Sculpin	ND	0.39	*
	R01SH131	Sculpin	ND	0.39	*
	R03WD153	Stickleback	ND	0.93	*
	R03WD155	Stickleback	ND	0.93	*
	R03WD153	Tadpole	ND	0.93	*
	R01SH074	Amphipods	ND	0.89	*
	R01SH118	Amphipods	ND	0.66	*
	R01SH131	Amphipods	ND	0.74	*
	RASS 3 Pond	Crayfish	ND	0.93	*
	RASS 3 Pond	Damselfly Larva	ND	0.93	*
Cadmium	R01SH074	Sculpin	0.11	13.8	0.00799
	R01SH118	Sculpin	ND	13.8	*
	R01SH131	Sculpin	0.15	13.8	0.0109
	R03WD153	Stickleback	ND	3.1	*
	R03WD155	Stickleback	ND	3.1	*
	R03WD153	Tadpole	2.17	3.1	0.7
	R01SH074	Amphipods	ND	63.4	*
	R01SH118	Amphipods	1.28	7.6	0.168
	R01SH131	Amphipods	0.98	4	0.245
	RASS 3 Pond	Crayfish	0.34	3.1	0.110
	RASS 3 Pond	Damselfly Larva	ND	3.1	*

TABLE 76 (Continued)

TISSUE CONCENTRATIONS OF METALS AND BIOACCUMULATION FACTORS FOR VERTEBRATE AND OTHER INVERTEBRATE RECEPTORS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Metal	Location	Tissue Type	[Tissue][a] (mg/kg)	[Sediment][b] (mg/kg)	[Tissue] / [Sediment]
Copper	R01SH074	Sculpin	23.7	226	0.105
	R01SH118	Sculpin	24.0	226	0.106
	R01SH131	Sculpin	21.9	226	0.0969
	R03WD153	Stickleback	7.49	44.6	0.168
	R03WD155	Stickleback	8.33	44.6	0.187
	R03WD153	Tadpole	30.4	44.6	0.682
	R01SH074	Amphipods	179	291	0.615
	R01SH118	Amphipods	187	129	1.45
	R01SH131	Amphipods	143	586	0.245
	RASS 3 Pond	Crayfish	121	44.6	2.70
	RASS 3 Pond	Damselfly Larva	17.1	44.6	0.384
Lead	R01SH074	Sculpin	ND	81.04	*
	R01SH118	Sculpin	ND	81.04	*
	R01SH131	Sculpin	ND	81.04	*
	R03WD153	Stickleback	ND	42.8	*
	R03WD155	Stickleback	ND	42.8	*
	R03WD153	Tadpole	19.6	42.8	0.457
	R01SH074	Amphipods	ND	62.7	*
	R01SH118	Amphipods	6.24	59.4	0.105
	R01SH131	Amphipods	4.57	231	0.0198
	RASS 3 Pond	Crayfish	ND	42.8	*
	RASS 3 Pond	Damselfly Larva	ND	42.8	*
Mercury	R01SH074	Sculpin	ND	0.48	*
	R01SH118	Sculpin	ND	0.48	*
	R01SH131	Sculpin	ND	0.48	*
	R03WD153	Stickleback	0.1	0.035	2.86
	R03WD155	Stickleback	0.15	0.035	4.29
	R03WD153	Tadpole	ND	0.035	*
	R01SH074	Amphipods	ND	0.67	*
	R01SH118	Amphipods	ND	0.4	*
	R01SH131	Amphipods	ND	0.35	*
	RASS 3 Pond	Crayfish	ND	0.035	*
	RASS 3 Pond	Damselfly Larva	ND	0.035	*

TABLE 76 (Continued)

TISSUE CONCENTRATIONS OF METALS AND BIOACCUMULATION FACTORS FOR VERTEBRATE AND OTHER INVERTEBRATE RECEPTORS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Metal	Location	Tissue Type	[Tissue][a] (mg/kg)	[Sediment][b] (mg/kg)	[Tissue] / [Sediment]
Nickel	R01SH074	Sculpin	ND	82.0	*
	R01SH118	Sculpin	ND	82.0	*
	R01SH131	Sculpin	ND	82.0	*
	R03WD153	Stickleback	0.75	51.2	0.0146
	R03WD155	Stickleback	ND	51.2	*
	R03WD153	Tadpole	22.8	51.2	0.446
	R01SH074	Amphipods	5.64	102	0.0553
	R01SH118	Amphipods	8.27	84.5	0.0979
	R01SH131	Amphipods	4.73	68.1	0.0695
	RASS 3 Pond	Crayfish	ND	51.2	*
	RASS 3 Pond	Damselfly Larva	ND	51.2	*
Selenium	R01SH074	Sculpin	ND	1.78	*
	R01SH118	Sculpin	ND	1.78	*
	R01SH131	Sculpin	ND	1.78	*
	R03WD153	Stickleback	4.01	0.83	4.83
	R03WD155	Stickleback	ND	0.83	*
	R03WD153	Tadpole	ND	0.83	*
	R01SH074	Amphipods	ND	3.1	*
	R01SH118	Amphipods	ND	2.5	*
	R01SH131	Amphipods	ND	2.7	*
	RASS 3 Pond	Crayfish	ND	0.83	*
	RASS 3 Pond	Damselfly Larva	ND	0.83	*
Vanadium	R01SH074	Sculpin	1.74	101	0.0172
	R01SH118	Sculpin	ND	101	*
	R01SH131	Sculpin	ND	101	*
	R03WD153	Stickleback	1.81	86.6	0.0209
	R03WD155	Stickleback	1.8	86.6	0.0208
	R03WD153	Tadpole	42.4	86.6	0.489
	R01SH074	Amphipods	7.05	123	0.0573
	R01SH118	Amphipods	9.02	97.8	0.0922
	R01SH131	Amphipods	5.98	82.5	0.0725
	RASS 3 Pond	Crayfish	2.49	86.6	0.0288
	RASS 3 Pond	Damselfly Larva	ND	86.6	*

TABLE 76 (Continued)

TISSUE CONCENTRATIONS OF METALS AND BIOACCUMULATION FACTORS FOR VERTEBRATE AND OTHER INVERTEBRATE RECEPTORS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Metal	Location	Tissue Type	[Tissue][a] (mg/kg)	[Sediment][b] (mg/kg)	[Tissue] / [Sediment]
Zinc	R01SH074	Sculpin	ND	2,319	*
	R01SH118	Sculpin	ND	2,319	*
	R01SH131	Sculpin	ND	2,319	*
	R03WD153	Stickleback	185	1,560	0.119
	R03WD155	Stickleback	194	1,560	0.124
	R03WD153	Tadpole	668	1,560	0.429
	R01SH074	Amphipods	281	2,460	0.114
	R01SH118	Amphipods	389	1,330	0.292
	R01SH131	Amphipods	334	5,750	0.0580
	RASS 3 Pond	Crayfish	115	1,560	0.0735
	RASS 3 Pond	Damselfly Larva	123	1,560	0.0785

Notes: An average was calculated for sediment for the RASS 3 Pond using one-half of the detection limit for nondetected data.
Detection limits were used as results when nondetects were found for tbulk sediments.
All values rounded to three significant figures, except when three significant figures were not available based on the analytical data.

RASS Remedial action subsite
mg/kg Milligram per kilogram
ND Anaylte not detected in sample

a Concentration of analyte in tissue sample; dry weight basis
b Concentration of analyte in sediment sample; dry weight basis
* Ratio not calculated when chemical was not detected in tissue

TABLE 77

SUMMARY OF METAL CONCENTRATIONS IN SEDIMENT IN AQUATIC HABITATS SAMPLED DURING MONITORING YEARS 1 THROUGH 5 FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Habitat	Metal	Summary Statistics for Sediment Concentrations							ER-M (mg/kg)
		Number of Locations	Minimum (mg/kg)	Median (mg/kg)	Maximum (mg/kg)	Mean[a] (mg/kg)	S.D. (mg/kg)	UCL_{95}[a] (mg/kg)	
Creek Reference	Arenic	3	2.42	2.74	3.09	2.75	0.33	3.31	70
	Cadmium	3	0.03	0.04	0.11	0.06	0.04	0.13	9.6
	Copper	3	10.08	10.72	18.60	13.13	4.75	21.13	270
	Lead	3	7.06	7.32	14.05	9.48	3.96	16.16	218
	Selenium	3	0.34	0.34	0.76	0.48	0.24	0.89	1.4
	Zinc	3	34.04	34.12	60.82	42.99	15.44	69.03	410
Ditches	Arsenic	36	16.74	61.15	1,358.60	166.07	247.98	235.90	70
	Cadmium	36	0.44	3.52	87.99	6.47	14.51	10.56	9.6
	Copper	36	47.12	174.53	1,271.50	237.77	242.76	306.14	270
	Lead	36	30.30	65.29	179.22	74.36	38.16	85.11	218
	Mercury	14	0.04	0.18	0.58	0.22	0.17	0.30	0.71
	Selenium	36	1.06	2.42	5.81	2.49	0.94	2.75	1.4
	Zinc	36	241.56	837.12	7,392.50	1,124.92	1,219.78	1,468.40	410
Nichols Creek	Arenic	29	2.37	5.75	87.53	10.93	17.31	16.40	70
	Cadmium	29	0.10	1.83	9.52	2.64	2.50	3.43	9.6
	Copper	29	11.59	25.03	156.95	40.44	38.25	52.53	270
	Lead	29	16.00	45.15	1,426.90	121.48	264.54	205.05	218
	Selenium	29	0.17	0.48	1.11	0.52	0.24	0.60	1.4
	Zinc	29	120.03	1,162.50	7,593.75	1,533.34	1,477.91	2,000.20	410
RASS 3 Pond	Arsenic	6	7.80	9.04	38.44	14.14	12.04	24.04	70
	Cadmium	6	2.23	6.62	12.52	6.85	3.88	10.05	9.6
	Copper	6	36.44	56.29	100.44	60.47	25.93	81.80	270
	Lead	6	33.22	55.94	168.73	84.22	55.64	129.99	218
	Mercury	5	0.02	0.04	0.06	0.04	0.02	0.06	0.71
	Selenium	6	0.45	0.98	1.41	0.94	0.32	1.20	1.4
	Zinc	6	1,537.20	2,241.10	5,435.20	2,649.00	1,468.93	3,857.40	410
RASS 4 Wetland	Arsenic	5	6.80	8.92	12.40	9.38	2.10	11.39	70
	Cadmium	5	0.14	0.36	2.70	0.78	1.08	1.82	9.6
	Copper	5	38.28	45.90	62.17	46.98	9.10	55.66	270
	Lead	5	30.40	32.04	192.18	64.37	71.48	132.52	218
	Mercury	5	0.08	0.17	0.67	0.26	0.23	0.48	0.71
	Selenium	5	1.21	1.83	7.08	2.71	2.47	5.07	1.4
	Zinc	5	158.40	184.60	312.25	216.81	62.96	276.83	410
Slough	Arsenic	55	7.48	44.38	288.48	65.99	58.08	79.09	70
	Cadmium	55	0.20	3.28	243.80	12.57	34.84	20.44	9.6
	Copper	55	17.16	104.78	431.25	118.22	66.59	133.25	270
	Lead	55	5.82	42.92	144.67	43.76	22.76	48.90	218
	Mercury	19	0.04	0.45	0.87	0.44	0.20	0.52	0.71
	Selenium	55	0.65	1.76	4.25	1.89	0.66	2.04	1.4
	Zinc	55	47.47	698.23	28,080.00	1,951.14	4,011.35	2,856.36	410

Notes:

a Shaded cells indicate mean and UCL_{95} concentrations that exceed the ER-M; One-half of the validated result was used for all nondetected analytes.

ER-M Effects-range median

mg/kg Milligram per kilogram

S.D. Standard deviation of the arithmetic areawide mean

UCL_{95} One-sided 95 percent upper confidence limit for the areawide means at individual locations. Location means are the means for monitoring years 1 through 5. Calculation of the UCL_{95} assumes a normal distribution.

TABLE 78

DATA SUMMARY FOR THE TOPSMELT SEDIMENT-WATER INTERFACE BIOASSAYS CONDUCTED IN 1998 AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Control	Sampling Location											
		R01SH023	R01SH028	R01SH029	R01SH074	R01SH082	R01SH118	R01SH131	R01SH134	R03WD154	R03WD156		
Mean Percent Hatch	95.0	95.0	87.5	97.5	85.0	87.5	93.3	95.0	95.0	97.5	95.0		
First Hatch Day	8	8	8	8	7	8	8	8	8	8	8		
Mean Temperature (°C)	20.4	20.3	20.3	20.3	20.4	20.4	20.4	20.4	20.4	20.4	20.4		
Mean pH	7.93	7.99	7.74	7.98	7.87	7.84	7.25	6.94	7.70	6.95	6.98		
Mean Salinity (ppt)	20.4	17.7	17.9	17.2	17.2	18.2	17.8	17.5	17.2	17.1	17.0		
DO at Day 12[a]	7.9	7.3	7.7	7.8	6.7	7.8	7.7	7.7	7.8	6.3	7.8		
Percent DO Saturation[b]	97	89	94	95	82	95	94	94	95	77	95		
Mean DO	7.8	7.6	7.9	7.8	7.8	7.8	7.8	7.9	7.5	7.7	7.7		
% DO Saturation[c]	95	93	97	95	95	95	95	97	92	94	94		
Ammonia (mg/L)	0.035	6.3	0.13	0.24	7.0	0.043	4.7	0.025	0.58	0.10	0.15		
Sediment pH	NA	7.7	7.5	7.4	7.7	7.7	NA	7.6	8.0	7.5	7.4		
Percent Clay	NA	35.2	48.6	44.8	48.0	55.9	NA	28.6	55.7	56.7	52.8		
TOC (mg/L)	NA	68,000	115,000	182,000	129,000	112,000	NA	124,000	122,000	70,000	56,000		
Sulfide (mg/kg)	NA	1470	197	139	470	1040	NA	26	553	629	215		
Sediment Metal												**ER-L**	**ER-M**
Arsenic (mg/kg)	NA	12.7	24.6	47.6	**87.1**	12.6	**202.0**	48.3	32.1	10.1	7.7	8.2	70.0
Cadmium (mg/kg)	NA	0.13	0.48	1.8	8.2	ND	1.90	2.8	**11.3**	2.9	3.1	1.2	9.6
Copper (mg/kg)	NA	69.4	77.8	104	**596**	45.1	105.0	89.9	58.6	55.5	39.8	34.0	270
Lead (mg/kg)	NA	22.6	24.4	29.5	59.4	11.8	33.0	39.1	19.9	59.2	28.4	46.7	218
Selenium (mg/kg)	NA	**1.5**	**2.0**	**2.6**	**2.2**	**1.5**	**1.8**	**1.7**	**1.6**	1.4	1.3	0.70	1.4
Zinc (mg/kg)	NA	194	345	**598**	**3,300**	381	**873**	**1,030**	**1,390**	**1,680**	**1,170**	150	410

Notes: Bolded numbers represent values greater than the ER-M.
The shaded cell for mean percent hatch indicates statistical significance from the laboratory control. No samples exceed the threshold level of concern (≤ 80 percent of laboratory controls) identified in Table 54.

DO Dissolved oxygen (mg/L)
ER-L Effects-range low
ER-M Effects-range median
mg/kg Milligram per kilogram
mg/L Milligram per liter
ND Not detected
NA Not applicable
ppt Part per thousand
TOC Total organic carbon

a DO in Replicate D on Day 12.
b The percent dissolved oxygen saturation in Replicate D on Day 12.
c The percent mean dissolved oxygen saturation.

Sources:

Long, E.R., and Others. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management.* Volume 19, Number 1. Pages 81 through 97.

TABLE 79

CORRELATIONS OF TOPSMELT BIOASSAY AND BULK-SEDIMENT CHEMISTRY RESULTS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Variables	Percent Hatch	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc
Percent Hatch		-0.12 p< .732 (N= 10)	-0.07 p< .858 (N= 10)	**-0.64** p< .046 (N= 10)	0.02 p< .964 (N= 10)	-0.19 p< .596 (N= 10)	-0.28 p< .426 (N= 10)
Arsenic	-0.12 p< .732 (N= 10)		0.08 p< .836 (N= 10)	0.31 p< .383 (N= 10)	0.21 p< .564 (N= 10)	0.33 p< .355 (N= 10)	0.20 p< .581 (N= 10)
Cadmium	-0.07 p< .858 (N= 10)	0.08 p< .836 (N= 10)		0.46 p< .180 (N= 10)	0.26 p< .477 (N= 10)	0.05 p< .888 (N= 10)	**0.70** p< .023 (N= 10)
Copper	**-0.64** p< .046 (N= 10)	0.31 p< .383 (N= 10)	0.46 p< .180 (N= 10)		0.60 p< .066 (N= 10)	0.33 p< .358 (N= 10)	0.84 p< .002 (N= 10)
Lead	0.02 p< .964 (N= 10)	0.21 p< .564 (N= 10)	0.26 p< .477 (N= 10)	0.60 p< .066 (N= 10)		0.16 p< .657 (N= 10)	**0.78** p< .007 (N= 10)
Selenium	-0.19 p< .596 (N= 10)	0.33 p< .355 (N= 10)	0.05 p< .888 (N= 10)	0.33 p< .358 (N= 10)	0.16 p< .657 (N= 10)		0.15 p< .680 (N= 10)
Zinc	-0.28 p< .426 (N= 10)	0.20 p< .581 (N= 10)	**0.70** p< .023 (N= 10)	**0.84** p< .002 (N= 10)	**0.78** p< .007 (N= 10)	0.15 p< .680 (N= 10)	

Notes: Bolded numbers are significant correlations at $p < 0.05$
p is the significance probability for the correlation coefficient

TABLE 80

DATA SUMMARY FOR *EOHAUSTORIUS* BIOASSAYS CONDUCTED IN 1995 FOR THE QUALITATIVE ECOLOGICAL ASSESSMENT AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Eohaustorius	**Lab Control C1[c]**				**Lab Control C2[c]**	**Lab Control C3[c]**		**Lab Control C4[c]**				**Lab Control C5[c]**		**Lab Control C6[c]**					
Whole Sediment Bioassay	**Control C1**	**R01SS011 (Unit 2)**	**R01SS078 (Unit 6)**	**R01SS091 (Unit 6)**	**Control C2**	**Control C3**	**R01SS095 (Unit 4)**	**Control C4**	**R01SH028 (Unit 9)**	**R01SS084 (Unit 6)**	**R01SS016 (Unit 2)**	**Control C5**	**R01SH029 (Unit 9)**	**Control C6**	**R03WD153 (Unit 13)**	**R03WD154 (Unit 13)**	**R04WD204 (Unit 15)**		
Survival[a] (Percent)	99	85	86	85	99	97	89	96	89	92	82	96	79	95	72	94	94		
Reburial[a] (Percent)	99	82	83	80	99	96	88	95	84	91	80	96	79	94	57	93	94		
TOC (mg/kg)	NA	65,400	157,000	164,000	NA	NA	201,000	NA	16,600	NA	135,000	NA	42,700	NA	10,900	NA	35,200		
pH	NA	7	7	7	NA	NA	7	NA	8	NA	7	NA	8	NA	7	NA	8		
Percent Fines[b] (< 250 µm)	NA	98	96	97	NA	NA	97	NA	100	NA	98	NA	99	NA	100	NA	98		
Sediment Oxygen Demand (mg/kg)	NA	NA	22	NA	NA	NA	NA	NA	98	NA	40	NA	36	NA	10	NA	14		
Sulfide (mg/kg)	NA	28.4	51.6	34.9	NA	NA	NA	NA	197	43.9	NA	NA	139	NA	137	629	813		
Ammonia (mg/kg)	NA	126	172	111	NA	NA	NA	NA	44.7	93.7	3.2	NA	49.3	NA	21.3	97.9	49.7		
Sediment (Analytical Laboratory)																		**ER-L**	**ER-M**
Arsenic (mg/kg)	NA	**73.6**	**759**	**1,050**	NA	NA	**137**	NA	**94.2**	**632**	24.5	NA	15.1	NA	7.8	13.8	6.7	8.2	70.0
Cadmium (mg/kg)	NA	0.16	0.21	0.19	NA	NA	2.3	NA	1	0.16	0.1	NA	0.11	NA	6.9	1.7	0.52	1.2	9.6
Copper (mg/kg)	NA	86.4	75.9	**306**	NA	NA	126	NA	84.8	**441**	50.4	NA	51.4	NA	28.1	56.4	48.2	34.0	270
Lead (mg/kg)	NA	72.7	39.7	132	NA	NA	183	NA	33.9	140	63.5	NA	13.2	NA	17.5	25.6	96.5	46.7	218
Selenium (mg/kg)	NA	**2.2**	1.1	**3.5**	NA	NA	**3.1**	NA	**1.5**	**3.1**	**2.7**	NA	1.3	NA	0.74	0.89	**1.6**	0.70	1.4
Zinc (mg/kg)	NA	172	168	209	NA	NA	**1970**	NA	386	**560**	145	NA	76.3	NA	**2,490**	448	255	150	410

Eohaustorius	**Lab Control C7[c]**							**Lab Control C8[c]**					**Lab Control C9[c]**				
Whole Sediment Bioassay (Continued)	**Control C7**	**R01DH067 (Unit 7)**	**R01SH077 (Unit 10)**	**R01DH099 (Unit 7)**	**R01DH100 (Unit 7)**	**R01SH097 (Unit 11)**	**R01SH131 (Unit 10)**	**Control C8**	**MHRSS001 (Unit 1)**	**R01SH043 (Unit 9)**	**R01SH074 (Unit 10)**	**R01SS024 (Unit 2)**	**Control C9**	**MHRSS003 (Unit 1)**	**MHRSS005 (Unit 1)**		
Survival[a] (Percent)	94	78	72	82	88	73	83	94	89	85	83	68	93	73	**67**		
Reburial[a] (Percent)	94	75	66	80	87	68	82	95	80	85	79	67	93	67	61		
TOC (mg/kg)	NA	139,000	31,200	70,200	86,400	16,800	30,200	NA	525	29,200	39,700	25,500	NA	53,900	67,500		
pH	NA	7	7	7	7	8	7	NA	7	8	8	7	NA	6	6		
Percent Fines[b] (< 250 µm)	NA	97	100	99	98	99	99	NA	79	99	99	100	NA	98	99		
Sediment Oxygen Demand (mg/kg)	NA	65	14	124	68	28	13	NA		84	57	4	NA	13	35		
Sulfide (mg/kg)	NA	1,890	187	3,600	1,850	280	25.7	NA	12.7	1,000	470	17.5	NA	22.7	55.8		
Ammonia (mg/kg)	NA	312	47.7	163	196	26.5	25.6	NA	9.1	94	108	63.5	NA	518	518		
Sediment (Analytical Laboratory)																**ER-L**	**ER-M**
Arsenic (mg/kg)	NA	**1,100**	**138**	**184**	**138**	30	**74.6**	NA	5.1	14.8	**103**	15.4	NA	14.5	13.6	8.2	70.0
Cadmium (mg/kg)	NA	3.1	**33.5**	**16.5**	3.6	7.5	**9.8**	NA	0.05	0.15	**63.4**	0.1	NA	0.09	0.1	1.2	9.6
Copper (mg/kg)	NA	**569**	219	**392**	171	61.4	149	NA	9.7	73.4	**291**	93.8	NA	57.4	45	34.0	270
Lead (mg/kg)	NA	168	34.9	61.5	48.7	22.2	61	NA	7.5	28.3	62.7	38.8	NA	58.1	17.1	46.7	218
Selenium (mg/kg)	NA	**4.1**	**1.5**	**4.2**	**4.2**	**2**	**2.5**	NA	0.58	**2.1**	**3.1**	**1.6**	NA	**1.6**	1.2	0.70	1.4
Zinc (mg/kg)	NA	**1,410**	**5,840**	**1,650**	**826**	**1,780**	**2,500**	NA	38.5	214	**2,460**	405	NA	111	65.4	150	410

Notes: Shaded cells for survival and reburial indicate statistical significance from laboratory controls; bolded cells indicate survival less than the RWQCB reference envelope edge.
Bolded numbers for sediment chemistry results indicate values greater than the ER-M.

ER-L Effects-range low
ER-M Effects-range median
µm Micrometer
mg/kg Milligram per kilogram
NA Not applicable
RWQCB California Regional Water Quality Control Board
TOC Total organic carbon
a Mean of five replicates
b Percent of samples with grain size less than 250 µm
c Multiple laboratory controls are a result of variances in sample analyses.

Sources:

Long, E.R., and others. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management.* Volume 19, Number 1. Pages 81 through 97.

TABLE 81

DATA SUMMARY FOR THE *EOHAUSTORIUS* BIOASSAYS CONDUCTED IN OCTOBER 2000 AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Sampling Location								
***Eohaustorius* Whole Sediment Bioassay**	**Control**	**R01DH265 (Unit 7)**	**R01DH302 (Unit 7)**	**R01DH303 (Unit 7)**	**R01SH304 (Unit 7)**	**R01SH305 (Unit 7)**	**R01SH306 (Unit 7)**	**R01SH307 (Unit 7)**		
Survival (Percent)	96	94	86	81	91	**62**	89	81		
Reburial (Percent)	100	98.9	99.0	100	100	92.0	97.8	92.4		
Overlying Water Parameters (Bioassay Laboratory)										
Mean Temperature (°C)	15.5	15.4	15.5	15.6	15.5	15.4	15.5	15.6		
Mean pH	7.95	7.84	7.26	7.81	7.90	7.97	8.14	8.18		
Mean Salinity (ppt)	20.5	20.5	19.8	19.7	18.7	18.8	18.6	18.9		
Mean DO (mg/L)	8.5	8.4	8.3	8.2	8.1	8.2	8.3	8.4		
Total Ammonia, Day 0 (mg/L)[a]	NA	0.15	0.28	0.12	0.63	0.72	1.12	1.01		
Total Ammonia, Day 2 (mg/L)[a]	NA	<0.01	<0.01	<0.01	0.55	0.78	1.19	0.79		
Total Ammonia, Day 8 (mg/L)[a]	NA	<0.01	<0.01	<0.01	0.55	1.80	1.65	2.03		
Porewater Parameters (Bioassay Laboratory)										
pH, Day 0	NA	6.92	6.71	7.20	7.27	7.39	7.43	7.29		
Salinity, Day 0 (ppt)	NA	17.9	17.1	12.9	9.0	9.3	7.7	9.1		
DO, Day 0 (mg/L)	NA	1.2	2.1	4.7	3.5	4.8	5.7	4.7		
Total Ammonia, Day 0 (mg/L)	NA	0.54	0.47	0.31	4.09	2.89	6.27	5.76		
Total Ammonia, Day 10 (mg/L)	NA	1.91	<0.01	0.47	0.55	4.32	3.70	5.48		
Sulfide, Day 0 (mg/L)[b]	NA	0.14	0.05	0.10	0.04	0.04	0.01	0.05		
Sediment (Analytical Laboratory)									**ER-L**	**ER-M**
Arsenic (mg/kg)	NA	**385.00**	**344.00**	**351.00**	**72.50**	49.20	**71.40**	58.30	8.2	70
Cadmium (mg/kg)	NA	**63.80**	**31.40**	**12.60**	**15.90**	5.60	**11.80**	**11.30**	1.2	9.6
Copper (mg/kg)	NA	**892.00**	**560.00**	**858.00**	117.00	95.70	129.00	102.00	34	270
Lead (mg/kg)	NA	54.30	43.30	94.80	58.90	47.00	71.90	65.70	46.7	218
Selenium (mg/kg	NA	**2.80**	0.75	**1.70**	0.65	0.50	**2.10**	0.55	0.7	1.4
Zinc (mg/kg)	NA	**4,300.00**	**1,870.00**	**2,950.00**	**3,000.00**	**1,990.00**	**2,720.00**	**2,320.00**	150	410

Notes: Shaded cells for survival and growth indicate statistical significance from the laboratory control; bolded text indicates survival less than the RWQCB reference envelope edge
Bolded numbers for sediment chemistry results represent concentrations greater than the ER-M.

°C Degrees Centigrade
DO Dissolved oxygen
ER-L Effects range-low (Long and Others 1995)
ER-M Effects range-median (Long and Others 1995)
mg/kg Milligrams per kilogram
mg/L Milligrams per liter
NA Not analyzed
ppt Parts per thousand

a The tolerance limit for total ammonia for *Eohaustorius estuarius* is 60 mg/L.
b The lowest observed effect concentration for total sulfide *Eohaustorius estuarius* is 1.93 mg/L (Knezovich and Others 1996).

Sources:

Knezovich, J.P., and Others. 1996. "Sulfide Tolerance of Four Marine Species Used to Evaluate Sediment and Pore-Water Toxicity."*Bulletin of Environmental Contamination and Toxicology.* Volume 57, Number 3. Page 450.
Long, E.R., and Others. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environmental Management. Volume 19, Number 1. Pages 81 through 97.
San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Evaluation and Use of Sediment Reference Ssites and Toxicity Tests in San Francisco Bay.: April.
U.S. Environmental Protection Agency. 1994. "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates." Office of Research and Development, Duluth, Minnesota
EPA 600/R-94/024.

TABLE 82

CORRELATIONS FOR *EOHAUSTORIUS* BIOASSAY AND BULK SEDIMENT CHEMISTRY RESULTS
FIVE-PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Results for *Eohaustorius* Bioassays Conducted in 1995											
Variables	**Survival**	**Reburial**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**	**Sulfide**	**TOC**	**pH**
Percent Survival		**0.95** p<0.000 (N= 23)	0.14 p< .526 (N= 23)	-0.15 p< .488 (N= 23)	0.13 p< .544 (N= 23)	0.37 p< .086 (N= 23)	0.29 p< .181 (N= 23)	-0.33 p< .125 (N= 23)	0.22 p< .344 (N= 21)	0.31 p< .167 (N= 21)	0.45 p< .042 (N= 21)
Percent Reburial	**0.95** p<0.000 (N= 23)		0.14 p< .512 (N= 23)	-0.14 p< .533 (N= 23)	0.08 p< .717 (N= 23)	0.32 p< .135 (N= 23)	0.18 p< .409 (N= 23)	-0.30 p< .167 (N= 23)	0.15 p< .525 (N= 21)	0.25 p< .278 (N= 21)	0.42 p< .056 (N= 21)
Arsenic	0.14 p< .526 (N= 23)	0.14 p< .512 (N= 23)		-0.10 p< .656 (N= 23)	**0.71** p<0.000 (N= 23)	**0.62** p< .002 (N= 23)	**0.47** p< .025 (N= 23)	-0.05 p< .803 (N= 23)	0.13 p< .588 (N= 21)	**0.65** p< .001 (N= 21)	-0.13 p< .573 (N= 21)
Cadmium	-0.15 p< .488 (N= 23)	-0.14 p< .533 (N= 23)	-0.10 p< .656 (N= 23)		0.30 p< .159 (N= 23)	-0.06 p< .775 (N= 23)	0.20 p< .366 (N= 23)	**0.66** p< .001 (N= 23)	0.12 p< .614 (N= 21)	-0.20 p< .381 (N= 21)	0.24 p< .291 (N= 21)
Copper	0.13 p< .544 (N= 23)	0.08 p< .717 (N= 23)	**0.71** p<0.000 (N= 23)	0.30 p< .159 (N= 23)		**0.65** p< .001 (N= 23)	**0.76** p<0.000 (N= 23)	0.27 p< .215 (N= 23)	**0.51** p< .019 (N= 21)	0.37 p< .102 (N= 21)	-0.04 p< .876 (N= 21)
Lead	0.37 p< .086 (N= 23)	0.32 p< .135 (N= 23)	**0.62** p< .002 (N= 23)	-0.06 p< .775 (N= 23)	**0.65** p< .001 (N= 23)		**0.66** p< .001 (N= 23)	0.03 p< .885 (N= 23)	0.23 p< .325 (N= 21)	**0.74** p<0.000 (N= 21)	-0.10 p< .664 (N= 21)
Selenium	0.29 p< .181 (N= 23)	0.18 p< .409 (N= 23)	**0.47** p< .025 (N= 23)	0.20 p< .366 (N= 23)	**0.76** p<0.000 (N= 23)	**0.66** p< .001 (N= 23)		0.11 p< .625 (N= 23)	**0.66** p< .001 (N= 21)	**0.51** p< .017 (N= 21)	0.00 p< .989 (N= 21)
Zinc	-0.33 p< .125 (N= 23)	-0.30 p< .167 (N= 23)	-0.05 p< .803 (N= 23)	**0.66** p< .001 (N= 23)	0.27 p< .215 (N= 23)	0.03 p< .885 (N= 23)	0.11 p< .625 (N= 23)		0.08 p< .723 (N= 21)	-0.14 p< .532 (N= 21)	0.03 p< .883 (N= 21)
Sulfide	0.22 p< .344 (N= 21)	0.15 p< .525 (N= 21)	0.13 p< .588 (N= 21)	0.12 p< .614 (N= 21)	**0.51** p< .019 (N= 21)	0.23 p< .325 (N= 21)	**0.66** p< .001 (N= 21)	0.08 p< .723 (N= 21)		0.22 p< .367 (N= 19)	0.05 p< .836 (N= 19)
TOC	0.31 p< .167 (N= 21)	0.25 p< .278 (N= 21)	**0.65** p< .001 (N= 21)	-0.20 p< .381 (N= 21)	0.37 p< .102 (N= 21)	**0.74** p<0.000 (N= 21)	**0.51** p< .017 (N= 21)	-0.14 p< .532 (N= 21)	0.22 p< .367 (N= 19)		-0.30 p< .180 (N= 21)
pH	**0.45** p< .042 (N= 21)	0.42 p< .056 (N= 21)	-0.13 p< .573 (N= 21)	0.24 p< .291 (N= 21)	-0.04 p< .876 (N= 21)	-0.10 p< .664 (N= 21)	0.00 p< .989 (N= 21)	0.03 p< .883 (N= 21)	0.05 p< .836 (N= 19)	-0.30 p< .180 (N= 21)	

Notes: Bolded numbers are significant correlations at $p < 0.05$
p is the significance probability for the correlation coefficient

TABLE 82 (Continued)

CORRELATIONS FOR *EOHAUSTORIUS* BIOASSAY AND BULK SEDIMENT CHEMISTRY RESULTS
FIVE-PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Results for *Eohaustorius* Bioassays Conducted in 2000														
Variables	**Survival**	**Reburial**	**Arsenic**	**Cadmium**	**Copper**	**Mercury**	**Lead**	**Selenium**	**Zinc**	**Sulfide**	**AVS**	**Ammonia**	**TOC**	**pH**
Percent Survival		0.74 p< .058 (N= 7)	0.61 p< .146 (N= 7)	0.42 p< .353 (N= 7)	0.58 p< .170 (N= 7)	0.21 p< .655 (N= 7)	0.28 p< .540 (N= 7)	0.48 p< .276 (N= 7)	0.49 p< .269 (N= 7)	0.48 p< .272 (N= 7)	0.02 p< .972 (N= 7)	0.46 p< .298 (N= 7)	0.40 p< .379 (N= 7)	0.11 p< .812 (N= 7)
Percent Reburial	0.74 p< .058 (N= 7)		0.38 p< .402 (N= 7)	0.59 p< .161 (N= 7)	0.34 p< .449 (N= 7)	-0.12 p< .801 (N= 7)	0.12 p< .796 (N= 7)	0.55 p< .200 (N= 7)	0.62 p< .134 (N= 7)	**0.85** p< .014 (N= 7)	0.52 p< .235 (N= 7)	0.22 p< .638 (N= 7)	-0.01 p< .989 (N= 7)	-0.35 p< .441 (N= 7)
Arsenic	0.61 p< .146 (N= 7)	0.38 p< .402 (N= 7)		0.71 p< .074 (N= 7)	**0.97** p<0.000 (N= 7)	0.24 p< .605 (N= 7)	0.10 p< .827 (N= 7)	0.53 p< .217 (N= 7)	0.43 p< .337 (N= 7)	0.42 p< .351 (N= 7)	-0.08 p< .858 (N= 7)	**0.78** p< .037 (N= 7)	0.32 p< .485 (N= 7)	-0.38 p< .406 (N= 7)
Cadmium	0.42 p< .353 (N= 7)	0.59 p< .161 (N= 7)	0.71 p< .074 (N= 7)		0.68 p< .091 (N= 7)	-0.09 p< .850 (N= 7)	-0.32 p< .482 (N= 7)	0.64 p< .121 (N= 7)	0.71 p< .075 (N= 7)	**0.86** p< .013 (N= 7)	0.49 p< .265 (N= 7)	0.33 p< .475 (N= 7)	-0.27 p< .564 (N= 7)	-0.74 p< .056 (N= 7)
Copper	0.58 p< .170 (N= 7)	0.34 p< .449 (N= 7)	**0.97** p<0.000 (N= 7)	0.68 p< .091 (N= 7)		0.36 p< .430 (N= 7)	0.26 p< .578 (N= 7)	0.63 p< .129 (N= 7)	0.56 p< .194 (N= 7)	0.42 p< .349 (N= 7)	-0.03 p< .950 (N= 7)	0.64 p< .119 (N= 7)	0.18 p< .700 (N= 7)	-0.42 p< .354 (N= 7)
Mercury	0.21 p< .655 (N= 7)	-0.12 p< .801 (N= 7)	0.24 p< .605 (N= 7)	-0.09 p< .850 (N= 7)	0.36 p< .430 (N= 7)		0.59 p< .165 (N= 7)	0.62 p< .140 (N= 7)	0.21 p< .653 (N= 7)	-0.13 p< .775 (N= 7)	-0.55 p< .198 (N= 7)	0.07 p< .886 (N= 7)	-0.08 p< .859 (N= 7)	-0.03 p< .952 (N= 7)
Lead	0.28 p< .540 (N= 7)	0.12 p< .796 (N= 7)	0.10 p< .827 (N= 7)	-0.32 p< .482 (N= 7)	0.26 p< .578 (N= 7)	0.59 p< .165 (N= 7)		0.33 p< .477 (N= 7)	0.23 p< .619 (N= 7)	-0.14 p< .772 (N= 7)	-0.18 p< .704 (N= 7)	0.00 p< .999 (N= 7)	0.12 p< .796 (N= 7)	0.12 p< .790 (N= 7)
Selenium	0.48 p< .276 (N= 7)	0.55 p< .200 (N= 7)	0.53 p< .217 (N= 7)	0.64 p< .121 (N= 7)	0.63 p< .129 (N= 7)	0.62 p< .140 (N= 7)	0.33 p< .477 (N= 7)		**0.81** p< .027 (N= 7)	0.69 p< .086 (N= 7)	0.18 p< .698 (N= 7)	0.09 p< .845 (N= 7)	-0.41 p< .356 (N= 7)	-0.64 p< .124 (N= 7)
Zinc	0.49 p< .269 (N= 7)	0.62 p< .134 (N= 7)	0.43 p< .337 (N= 7)	0.71 p< .075 (N= 7)	0.56 p< .194 (N= 7)	0.21 p< .653 (N= 7)	0.23 p< .619 (N= 7)	**0.81** p< .027 (N= 7)		**0.81** p< .026 (N= 7)	0.63 p< .128 (N= 7)	-0.17 p< .719 (N= 7)	-0.54 p< .211 (N= 7)	-0.58 p< .170 (N= 7)
Sulfide	0.48 p< .272 (N= 7)	**0.85** p< .014 (N= 7)	0.42 p< .351 (N= 7)	**0.86** p< .013 (N= 7)	0.42 p< .349 (N= 7)	-0.13 p< .775 (N= 7)	-0.14 p< .772 (N= 7)	0.69 p< .086 (N= 7)	**0.81** p< .026 (N= 7)		0.71 p< .073 (N= 7)	0.05 p< .919 (N= 7)	-0.41 p< .364 (N= 7)	-0.70 p< .078 (N= 7)
AVS	0.02 p< .972 (N= 7)	0.52 p< .235 (N= 7)	-0.08 p< .858 (N= 7)	0.49 p< .265 (N= 7)	-0.03 p< .950 (N= 7)	-0.55 p< .198 (N= 7)	-0.18 p< .704 (N= 7)	0.18 p< .698 (N= 7)	0.63 p< .128 (N= 7)	0.71 p< .073 (N= 7)		-0.44 p< .328 (N= 7)	-0.59 p< .166 (N= 7)	-0.51 p< .240 (N= 7)
Ammonia	0.46 p< .298 (N= 7)	0.22 p< .638 (N= 7)	**0.78** p< .037 (N= 7)	0.33 p< .475 (N= 7)	0.64 p< .119 (N= 7)	0.07 p< .886 (N= 7)	0.00 p< .999 (N= 7)	0.09 p< .845 (N= 7)	-0.17 p< .719 (N= 7)	0.05 p< .919 (N= 7)	-0.44 p< .328 (N= 7)		0.75 p< .053 (N= 7)	-0.04 p< .926 (N= 7)
TOC	0.40 p< .379 (N= 7)	-0.01 p< .989 (N= 7)	0.32 p< .485 (N= 7)	-0.27 p< .564 (N= 7)	0.18 p< .700 (N= 7)	-0.08 p< .859 (N= 7)	0.12 p< .796 (N= 7)	-0.41 p< .356 (N= 7)	-0.54 p< .211 (N= 7)	-0.41 p< .364 (N= 7)	-0.59 p< .166 (N= 7)	0.75 p< .053 (N= 7)		0.60 p< .156 (N= 7)
pH	0.11 p< .812 (N= 7)	-0.35 p< .441 (N= 7)	-0.38 p< .406 (N= 7)	-0.74 p< .056 (N= 7)	-0.42 p< .354 (N= 7)	-0.03 p< .952 (N= 7)	0.12 p< .790 (N= 7)	-0.64 p< .124 (N= 7)	-0.58 p< .170 (N= 7)	-0.70 p< .078 (N= 7)	-0.51 p< .240 (N= 7)	-0.04 p< .926 (N= 7)	0.60 p< .156 (N= 7)	

Notes: Bolded numbers are significant correlations at $p < 0.05$
p is the significance probability for the correlation coefficient

TABLE 83

CORRELATIONS OF *EOHAUSTORIUS* BIOASSAY RESULTS FROM 1995 AND CHEMICAL CONCENTRATIONS MEASURED IN SEDIMENT POREWATER AND EXTRACTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

***Eohaustorius* Bioassay and Sediment Porewater Results from 1995**									
Variables	**Survival**	**Reburial**	**Arsenic**	**Cadmium**	**Copper**	**Mercury**	**Lead**	**Selenium**	**Zinc**
Percent Survival		**0.90** p< .037 (N= 5)	0.21 p< .738 (N= 5)	-0.40 p< .509 (N= 5)	-0.74 p< .149 (N= 5)	-0.50 p< .386 (N= 5)	-0.66 p< .226 (N= 5)	**-0.93** p< .024 (N= 5)	0.07 p< .907 (N= 5)
Percent Reburial	**0.90** p< .037 (N= 5)		0.19 p< .761 (N= 5)	-0.28 p< .648 (N= 5)	-0.62 p< .267 (N= 5)	-0.39 p< .520 (N= 5)	-0.52 p< .372 (N= 5)	-0.87 p< .053 (N= 5)	0.04 p< .944 (N= 5)
Arsenic	0.21 p< .738 (N= 5)	0.19 p< .761 (N= 5)		-0.19 p< .757 (N= 5)	0.16 p< .793 (N= 5)	0.10 p< .876 (N= 5)	0.13 p< .837 (N= 5)	-0.37 p< .541 (N= 5)	-0.31 p< .612 (N= 5)
Cadmium	-0.40 p< .509 (N= 5)	-0.28 p< .648 (N= 5)	-0.19 p< .757 (N= 5)		0.79 p< .112 (N= 5)	**0.94** p< .017 (N= 5)	0.87 p< .056 (N= 5)	0.09 p< .889 (N= 5)	0.84 p< .076 (N= 5)
Copper	-0.74 p< .149 (N= 5)	-0.62 p< .267 (N= 5)	0.16 p< .793 (N= 5)	0.79 p< .112 (N= 5)		**0.93** p< .021 (N= 5)	**0.99** p< .002 (N= 5)	0.44 p< .460 (N= 5)	0.37 p< .542 (N= 5)
Mercury	-0.50 p< .386 (N= 5)	-0.39 p< .520 (N= 5)	0.10 p< .876 (N= 5)	**0.94** p< .017 (N= 5)	**0.93** p< .021 (N= 5)		**0.98** p< .005 (N= 5)	0.15 p< .804 (N= 5)	0.66 p< .225 (N= 5)
Lead	-0.66 p< .226 (N= 5)	-0.52 p< .372 (N= 5)	0.13 p< .837 (N= 5)	0.87 p< .056 (N= 5)	**0.99** p< .002 (N= 5)	**0.98** p< .005 (N= 5)		0.33 p< .587 (N= 5)	0.49 p< .402 (N= 5)
Selenium	**-0.93** p< .024 (N= 5)	-0.87 p< .053 (N= 5)	-0.37 p< .541 (N= 5)	0.09 p< .889 (N= 5)	0.44 p< .460 (N= 5)	0.15 p< .804 (N= 5)	0.33 p< .587 (N= 5)		-0.30 p< .621 (N= 5)
Zinc	0.07 p< .907 (N= 5)	0.04 p< .944 (N= 5)	-0.31 p< .612 (N= 5)	0.84 p< .076 (N= 5)	0.37 p< .542 (N= 5)	0.66 p< .225 (N= 5)	0.49 p< .402 (N= 5)	-0.30 p< .621 (N= 5)	

Notes: Bolded numbers are significant correlations at $p < 0.05$
p is the significance probability for the correlation coefficient

TABLE 83 (Continued)

CORRELATIONS OF *EOHAUSTORIUS* BIOASSAY RESULTS FROM 1995 AND CHEMICAL CONCENTRATIONS MEASURED IN SEDIMENT POREWATER AND EXTRACTS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

***Eohaustorius* Bioassay and Sediment WET-DI Results from 1995**									
Variables	**Survival**	**Reburial**	**Arsenic**	**Cadmium**	**Copper**	**Mercury**	**Lead**	**Selenium**	**Zinc**
Percent Survival		**0.94** p<0.000 (N= 14)	0.27 p< .349 (N= 14)	-0.27 p< .356 (N= 14)	0.07 p< .806 (N= 14)	0.13 p< .647 (N= 14)	-0.12 p< .673 (N= 14)	0.03 p< .925 (N= 14)	-0.13 p< .663 (N= 14)
Percent Reburial	**0.94** p<0.000 (N= 14)		0.30 p< .303 (N= 14)	-0.16 p< .580 (N= 14)	0.17 p< .560 (N= 14)	0.11 p< .699 (N= 14)	0.00 p< .999 (N= 14)	0.11 p< .696 (N= 14)	-0.02 p< .943 (N= 14)
Arsenic	0.27 p< .349 (N= 14)	0.30 p< .303 (N= 14)		-0.08 p< .784 (N= 14)	0.33 p< .244 (N= 14)	0.02 p< .933 (N= 14)	-0.07 p< .801 (N= 14)	-0.06 p< .837 (N= 14)	-0.07 p< .816 (N= 14)
Cadmium	-0.27 p< .356 (N= 14)	-0.16 p< .580 (N= 14)	-0.08 p< .784 (N= 14)		0.42 p< .130 (N= 14)	-0.28 p< .341 (N= 14)	0.48 p< .082 (N= 14)	0.46 p< .097 (N= 14)	**0.83** p<0.000 (N= 14)
Copper	0.07 p< .806 (N= 14)	0.17 p< .560 (N= 14)	0.33 p< .244 (N= 14)	0.42 p< .130 (N= 14)		-0.20 p< .495 (N= 14)	**0.90** p<0.000 (N= 14)	**0.87** p<0.000 (N= 14)	**0.80** p< .001 (N= 14)
Mercury	0.13 p< .647 (N= 14)	0.11 p< .699 (N= 14)	0.02 p< .933 (N= 14)	-0.28 p< .341 (N= 14)	-0.20 p< .495 (N= 14)		-0.22 p< .458 (N= 14)	-0.21 p< .470 (N= 14)	-0.26 p< .365 (N= 14)
Lead	-0.12 p< .673 (N= 14)	0.00 p< .999 (N= 14)	-0.07 p< .801 (N= 14)	0.48 p< .082 (N= 14)	**0.90** p<0.000 (N= 14)	-0.22 p< .458 (N= 14)		**0.93** p<0.000 (N= 14)	**0.87** p<0.000 (N= 14)
Selenium	0.03 p< .925 (N= 14)	0.11 p< .696 (N= 14)	-0.06 p< .837 (N= 14)	0.46 p< .097 (N= 14)	**0.87** p<0.000 (N= 14)	-0.21 p< .470 (N= 14)	**0.93** p<0.000 (N= 14)		**0.84** p<0.000 (N= 14)
Zinc	-0.13 p< .663 (N= 14)	-0.02 p< .943 (N= 14)	-0.07 p< .816 (N= 14)	**0.83** p<0.000 (N= 14)	**0.80** p< .001 (N= 14)	-0.26 p< .365 (N= 14)	**0.87** p<0.000 (N= 14)	**0.84** p<0.000 (N= 14)	

Notes: Bolded numbers are significant correlations at $p < 0.05$
p is the significance probability for the correlation coefficient

TABLE 84

DATA SUMMARY FOR THE *HYALELLA* BIOASSAYS CONDUCTED IN OCTOBER 2000 AT THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

		Sampling Location														
***Hyalella* Whole Sediment Bioassay**	**Control**	**R01DH265 (Unit 7)**	**R01DH302 (Unit 7)**	**R01DH303 (Unit 7)**	**R01SH074 (Unit 10)**	**R01SH118 (Unit 10)**	**R01SH131 (Unit 10)**	**R01SH304 (Unit 11)**	**R01SH305 (Unit 11)**	**R01SH306 (Unit 11)**	**R01SH307 (Unit 11)**	**SLRSH01 (Unit 9)**	**SLRSH02 (Unit 9)**	**SLRSH03 (Unit 9)**		
Survival (Percent)	82.5	81.2	87.5	88.8	86.2	76.2	**57.5**	75.0	90.0	70.0	**47.5**	70.0	82.5	81.2		
Growth (weight, mg)	0.21	0.21	0.23	0.19	0.17	0.18	0.21	0.21	0.27	0.24	0.32	0.20	0.21	0.20		
Overlying Water Parameters (Bioassay Laboratory)																
Mean Temperature (^{o}C)	NA	22.5	22.5	22.5	22.6	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5		
pH, Day 0 After First Water Change	7.71	7.12	7.24	7.52	7.65	7.52	7.61	7.66	7.63	7.65	7.45	7.62	7.65	7.62		
pH, Day 14	7.57	7.48	7.45	7.65	7.42	8.71	8.40	8.13	7.89	8.17	7.80	7.86	8.76	8.30		
Alkalinity, Day 0 After First Water Change (mg/L)[a]	76	764	550	74	72	76	64	74	72	76	86	62	60	64		
Alkalinity, Day 14 (mg/L)[a]	99	127	102	82	80	96	88	63	104	95	81	64	90	75		
Mean DO, Old[b] (mg/L)[d]	6.5	6.70	6.80	6.90	6.30	6.30	6.40	6.30	6.20	6.20	5.90[a]	6.60	6.20	6.30		
Mean DO, New[c] (mg/L)[d]	7.5	6.90	7.10	7.30	7.20	7.20	7.20	7.10	6.90	6.80	6.80	7.30	7.20	7.90		
Total Ammonia, Day 0 After First Water Change (mg/L)[e]	<0.01	<0.01	<0.01	0.03	0.35	0.31	0.12	0.23	0.18	0.44	0.43	0.84	<0.01	0.02		
Total Ammonia, Day 14 (mg/L)[e]	<0.01	0.37	0.24	0.14	<0.01	<0.01	0.05	0.22	1.03	0.56	0.87	<0.01	<0.01	<0.01		
Hardness, Day 0 After First Water Change (mg/L)	156	372	202	170	146	152	156	182	166	156	180	142	144	136		
Hardness, Day 14 (mg/L)	171	162	149	132	104	104	118	120	123	112	110	97	120	97		
Porewater Parameters (Bioassay Laboratory)																
pH	NA	6.92	6.71	7.20	7.23	7.20	7.42	7.27	7.39	7.43	7.29	7.17	7.45	7.16		
Salinity (ppt)	NA	17.9	17.1	12.9	7.2	7.3	8.3	9.0	9.3	7.7	9.1	8.4	7.7	6.8		
DO (mg/L)	NA	1.2	2.1	4.7	5.7	4.2	4.5	3.5	4.8	5.7	4.7	5.5	5.5	3.8		
Total Ammonia (mg/L)	NA	0.54	0.47	0.31	3.86	5.71	4.54	4.09	2.89	6.27	5.76	2.64	1.85	3.19		
Sulfide (mg/L)	NA	0.14	0.05	0.10	0.06	0.01	0.10	0.04	0.04	0.01	0.05	0.01	0.02	0.02		
Sediment (Analytical Laboratory)															**ER-L**	**ER-M**
Arsenic (mg/kg)	NA	**385.00**	**344.00**	**351.00**	57.70	34.80	**182.00**	**72.50**	49.20	**71.40**	58.30	13.20	24.50	17.20	8.2	70
Cadmium (mg/kg)	NA	**63.80**	**31.40**	**12.60**	4.50	4.30	**16.20**	**15.90**	5.60	**11.80**	**11.30**	0.05	0.11	0.04	1.2	9.6
Copper (mg/kg)	NA	**892.00**	**560.00**	**858.00**	146.00	96.40	196.00	117.00	95.70	129.00	102.00	74.40	70.00	59.60	34	270
Lead (mg/kg)	NA	54.30	43.30	94.80	42.60	45.30	108.00	58.90	47.00	71.90	65.70	29.30	25.90	25.70	46.7	218
Selenium (mg/kg)	NA	**2.80**	0.75	**1.70**	0.28	0.40	0.38	0.65	0.50	**2.10**	0.55	0.29	0.27	0.25	0.7	1.4
Zinc (mg/kg)	NA	**4,300.00**	**1,870.00**	**2,950.00**	**804.00**	**1,040.00**	**2,640.00**	**3,000.00**	**1,990.00**	**2,720.00**	**2,320.00**	166.00	206.00	158.00	150	410

Notes: Shaded cells for survival and growth indicate statistical significance from the laboratory control; bolded text indicates survival less than 80 percent of control survival
Bolded numbers for sediment chemistry results indicate concentrations greater than the ER-M.

DO Dissolved oxygen
ER-L Effects range-low (Long and Others 1995)
ER-M Effects range-median (Long and Others 1995)
mg/kg Milligrams per kilogram
mg/L Milligrams per liter
NA Not analyzed
ppt Parts per thousand
a The mean 96-hour LC_{50} for 7-day old *Hyalella azteca* for alkalinity as calcium carbonate was 662 mg/L (Lasier and others 1997).
b Old refers to solutions that are approximately 24 hours old (immediately prior to water renewal).
c New refers to solutions that were just renewed.
d The 24-hour LC_{50} for dissolved oxygen for *Hyalella azteca* is 0.7 mg/L at 20°C (EPA 1994). Weight of *H. azteca* was reduced after 30-d exposure to 1.2 mg/L dissolved oxygen (EPA 1994).
e The LC_{50} in hard water for total ammonia for *Hyalella azteca* is 140 mg/L (Ankley and others 1995 as cited in EPA 1994). This LC_{50} varies with pH and water hardness.

Sources:

Lasier, P.J., P.V. Winger, and R.E. Reinert. 1997. "Toxicity of Alkalinity to *Hyalella azteca* ." *Bulletin of Environmental Contamination and Toxicology* . Volume 59. Pages 807 through 814.
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TABLE 85

CORRELATIONS OF *HYALELLA* BIOASSAY AND BULK CHEMISTRY RESULTS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Variables	Growth	Survival	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Sulfide	AVS	Ammonia	TOC	pH
Growth		-0.49 p< .091 (N= 13)	-0.10 p< .758 (N= 13)	0.06 p< .847 (N= 13)	-0.17 p< .589 (N= 13)	-0.46 p< .112 (N= 13)	0.13 p< .680 (N= 13)	0.04 p< .910 (N= 13)	0.26 p< .387 (N= 13)	0.03 p< .916 (N= 13)	0.45 p< .126 (N= 13)	0.34 p< .251 (N= 13)	0.16 p< .610 (N= 13)	-0.43 p< .139 (N= 13)
Percent Survival	-0.49 p< .091 (N= 13)		0.27 p< .376 (N= 13)	0.07 p< .811 (N= 13)	0.36 p< .231 (N= 13)	0.42 p< .153 (N= 13)	-0.38 p< .203 (N= 13)	0.13 p< .684 (N= 13)	-0.13 p< .672 (N= 13)	-0.13 p< .669 (N= 13)	-0.44 p< .136 (N= 13)	0.22 p< .462 (N= 13)	0.29 p< .332 (N= 13)	0.11 p< .711 (N= 13)
Arsenic	-0.10 p< .758 (N= 13)	0.27 p< .376 (N= 13)		**0.80** p< .001 (N= 13)	**0.96** p<0.000 (N= 13)	0.02 p< .959 (N= 13)	0.44 p< .128 (N= 13)	**0.66** p< .014 (N= 13)	**0.67** p< .011 (N= 13)	0.44 p< .133 (N= 13)	0.43 p< .144 (N= 13)	**0.71** p< .006 (N= 13)	0.51 p< .076 (N= 13)	**-0.59** p< .034 (N= 13)
Cadmium	0.06 p< .847 (N= 13)	0.07 p< .811 (N= 13)	**0.80** p< .001 (N= 13)		**0.77** p< .002 (N= 13)	-0.23 p< .444 (N= 13)	0.23 p< .449 (N= 13)	**0.74** p< .004 (N= 13)	**0.77** p< .002 (N= 13)	**0.77** p< .002 (N= 13)	**0.68** p< .010 (N= 13)	**0.58** p< .039 (N= 13)	0.15 p< .621 (N= 13)	**-0.79** p< .001 (N= 13)
Copper	-0.17 p< .589 (N= 13)	0.36 p< .231 (N= 13)	**0.96** p<0.000 (N= 13)	**0.77** p< .002 (N= 13)		0.15 p< .618 (N= 13)	0.36 p< .232 (N= 13)	**0.73** p< .004 (N= 13)	**0.64** p< .019 (N= 13)	0.47 p< .106 (N= 13)	0.35 p< .245 (N= 13)	**0.68** p< .011 (N= 13)	0.43 p< .147 (N= 13)	**-0.59** p< .033 (N= 13)
Mercury	-0.46 p< .112 (N= 13)	0.42 p< .153 (N= 13)	0.02 p< .959 (N= 13)	-0.23 p< .444 (N= 13)	0.15 p< .618 (N= 13)		0.06 p< .838 (N= 13)	0.28 p< .352 (N= 13)	-0.18 p< .562 (N= 13)	-0.20 p< .511 (N= 13)	-0.53 p< .064 (N= 13)	-0.20 p< .515 (N= 13)	-0.20 p< .522 (N= 13)	0.20 p< .519 (N= 13)
Lead	0.13 p< .680 (N= 13)	-0.38 p< .203 (N= 13)	0.44 p< .128 (N= 13)	0.23 p< .449 (N= 13)	0.36 p< .232 (N= 13)	0.06 p< .838 (N= 13)		0.36 p< .231 (N= 13)	**0.68** p< .010 (N= 13)	-0.02 p< .938 (N= 13)	**0.57** p< .044 (N= 13)	0.28 p< .362 (N= 13)	0.24 p< .436 (N= 13)	-0.33 p< .276 (N= 13)
Selenium	0.04 p< .910 (N= 13)	0.13 p< .684 (N= 13)	**0.66** p< .014 (N= 13)	**0.74** p< .004 (N= 13)	**0.73** p< .004 (N= 13)	0.28 p< .352 (N= 13)	0.36 p< .231 (N= 13)		**0.77** p< .002 (N= 13)	**0.69** p< .009 (N= 13)	0.49 p< .092 (N= 13)	**0.58** p< .036 (N= 13)	0.13 p< .669 (N= 13)	**-0.76** p< .003 (N= 13)
Zinc	0.26 p< .387 (N= 13)	-0.13 p< .672 (N= 13)	**0.67** p< .011 (N= 13)	**0.77** p< .002 (N= 13)	**0.64** p< .019 (N= 13)	-0.18 p< .562 (N= 13)	**0.68** p< .010 (N= 13)	**0.77** p< .002 (N= 13)		0.53 p< .062 (N= 13)	**0.88** p<0.000 (N= 13)	**0.64** p< .019 (N= 13)	0.28 p< .356 (N= 13)	**-0.79** p< .001 (N= 13)
Sulfide	0.03 p< .916 (N= 13)	-0.13 p< .669 (N= 13)	0.44 p< .133 (N= 13)	**0.77** p< .002 (N= 13)	0.47 p< .106 (N= 13)	-0.20 p< .511 (N= 13)	-0.02 p< .938 (N= 13)	**0.69** p< .009 (N= 13)	0.53 p< .062 (N= 13)		0.53 p< .063 (N= 13)	0.31 p< .297 (N= 13)	-0.07 p< .821 (N= 13)	**-0.56** p< .045 (N= 13)
AVS	0.45 p< .126 (N= 13)	-0.44 p< .136 (N= 13)	0.43 p< .144 (N= 13)	**0.68** p< .010 (N= 13)	0.35 p< .245 (N= 13)	-0.53 p< .064 (N= 13)	**0.57** p< .044 (N= 13)	0.49 p< .092 (N= 13)	**0.88** p<0.000 (N= 13)	0.53 p< .063 (N= 13)		0.42 p< .149 (N= 13)	0.11 p< .724 (N= 13)	**-0.70** p< .007 (N= 13)
Ammonia	0.34 p< .251 (N= 13)	0.22 p< .462 (N= 13)	**0.71** p< .006 (N= 13)	**0.58** p< .039 (N= 13)	**0.68** p< .011 (N= 13)	-0.20 p< .515 (N= 13)	0.28 p< .362 (N= 13)	**0.58** p< .036 (N= 13)	**0.64** p< .019 (N= 13)	0.31 p< .297 (N= 13)	0.42 p< .149 (N= 13)		**0.81** p< .001 (N= 13)	**-0.66** p< .014 (N= 13)
TOC	0.16 p< .610 (N= 13)	0.29 p< .332 (N= 13)	0.51 p< .076 (N= 13)	0.15 p< .621 (N= 13)	0.43 p< .147 (N= 13)	-0.20 p< .522 (N= 13)	0.24 p< .436 (N= 13)	0.13 p< .669 (N= 13)	0.28 p< .356 (N= 13)	-0.07 p< .821 (N= 13)	0.11 p< .724 (N= 13)	**0.81** p< .001 (N= 13)		-0.16 p< .602 (N= 13)
pH	-0.43 p< .139 (N= 13)	0.11 p< .711 (N= 13)	**-0.59** p< .034 (N= 13)	**-0.79** p< .001 (N= 13)	**-0.59** p< .033 (N= 13)	0.20 p< .519 (N= 13)	-0.33 p< .276 (N= 13)	**-0.76** p< .003 (N= 13)	**-0.79** p< .001 (N= 13)	**-0.56** p< .045 (N= 13)	**-0.70** p< .007 (N= 13)	**-0.66** p< .014 (N= 13)	-0.16 p< .602 (N= 13)	

Notes: Bolded numbers are significant correlations at $p < 0.05$
p is the significance probability for the correlation coefficient

TABLE 86

SIMULTANEOUSLY EXTRACTABLE METALS AND ACID VOLATILE SULFIDE DIFFERENCES IN LITIGATION AREA SEDIMENT FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Location by Habitat	Spatial Unit	Cadmium (mg/kg)	Cadmium (mmol)	Copper (mg/kg)	Copper (mmol)	Lead (mg/kg)	Lead (mmol)	Nickel (mg/kg)	Nickel (mmol)	Zinc (mg/kg)	Zinc (mmol)	SEM (mmol)	AVS (mg/kg)	AVS (mmol)	SEM-AVS (mmol)[a]
Ditches															
R01DH265	7	34.7	0.31	298	4.7	31.6	0.15	13.9	0.24	2790	42.7	48.06	4900	153	-105
R01DH302		48.3	0.43	356	5.6	33.5	0.16	18.3	0.32	3980	60.9	67.39	1720	54	14
R01DH303		7.3	0.06	201	3.2	34.7	0.17	29.3	0.50	2540	38.8	42.74	1610	50	-7
Sloughs															
R01SH304	11	15.5	0.14	75	1.2	46.2	0.22	31.4	0.53	3000	45.9	47.96	4390	137	-89
R01SH305		5.9	0.05	65.6	1.0	36.7	0.18	34.4	0.59	2370	36.2	38.10	1850	58	-20
R01SH306		9.2	0.08	70.4	1.1	33.5	0.16	36.0	0.61	2040	31.2	33.17	2180	68	-35
R01SH307		7.5	0.07	55.3	0.9	27.8	0.13	28.0	0.48	1540	23.6	25.10	4230	132	-107
R01SH074	10	1.6	0.01	60.1	0.9	21.4	0.10	26.1	0.44	781	11.9	13.45	833	26	-13
R01SH118		1.6	0.01	39.2	0.6	15.3	0.07	23.2	0.40	604	9.2	10.34	474	15	-4
R01SH131		0.5	0.00	19.1	0.3	20.7	0.10	16.5	0.28	222	3.4	4.08	3630	113	-109
Reference Areas															
SLRSH01	9	0.01	0.00	27.4	0.4	12.3	0.06	28.0	0.48	50.9	0.8	1.75	101	3	-1
SLRSH02		0.1	0.00	19.2	0.3	11.0	0.05	16.3	0.28	58.5	0.9	1.53	119	4	-2
SLRSH03		0.01	0.00	29.9	0.5	13.8	0.07	28.9	0.49	76.1	1.2	2.19	95.1	3	-1

Notes:

a Negative number indicates that AVS > SEM and that the metals present at the site are presumably bound with sulfides and not bioavailable. Positive number indicates that SEM > AVS and that the metals present at the site may be bioavailable.

mg/kg Milligam per kilogram
mmol Millimole
SEM Simultaneously extractable metals (sum total of cadmium, copper, lead, nickel, and zinc concentrations in mmol)
AVS Acid volatile sulfide

TABLE 87

SUMMARY OF THE APPROACH USED TO ESTIMATE RISK TO BIRDS AND MAMMALS FROM ORGANIC CHEMICALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptors Evaluated	Habitat for Exposure Evaluation	Use of Nondetect Data
California Black Rail	Ditches (Units 5 and 7)	One-half DL and Full dose
Mallard	RASS 3 Pond (Unit 13) Slough (Units 9, 10, and 11)	1/2 DL and Full dose
Great Blue Heron	RASS 3 Pond (Unit 13) Slough (Units 9, 10, and 11)	1/2 DL and Full dose
Northern Harrier	RASS 3 and 4 Upland (Units 14 and 16)	1/2 DL and Full dose
Salt Marsh Harvest Mouse	Marsh Surface (Units 1, 2, 4, 6, and 8)	1/2 DL and Full dose
River Otter	Slough (Units 9, 10, and 11)	1/2 DL and Full dose

Parameter	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	Typical	kg/day	Literature value; if no literature ingestion rate value was available, calculated with body weight using the Nagy and others (1999) metabolic rate equation.
Prey Concentration (site tissue available)	Maximum	mg/kg	Site-collected tissue data (fish, crayfish, tadpole, and clams); totals summed using 1/2 DL and full DL substituted for nondetects
Prey Concentration (no site tissue available)	Literature BAF × maximum soil or sediment	mg/kg	Literature-derived BAF (EPA 1999) used to calculate a tissue concentration for prey items with no site-specific organic data available (plants, rodents, and amphipods)
Ingestion $Rate_{sediment/soil}$	Typical	kg/day	Literature-based rate
Sediment and Soil Concentrations	Maximum	mg/kg	Soil collected from site during QEA; totals summed using 1/2 DL and full DL for nondetects
SUF	Typical	unitless	Based on literature-derived foraging range information
Body Weight	Typical	kg	Body weights from the literature; salt marsh harvest mice body weights are site-specific

TABLE 87 (Continued)

SUMMARY OF THE APPROACH USED TO ESTIMATE RISK TO BIRDS AND MAMMALS FROM ORGANIC CHEMICALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Notes:

1/2 DL	1/2 detection limit value substituted for nondetects in dose
BAF	Bioaccumulation factor (tissue concentration/soil concentration = BAF)
EPA	U.S. Environmental Protection Agency
Full DL	Full detection limit value substituted for nondetects in dose
kg	Kilogram
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
QEA	Qualitative ecological assessment (PRC Environmental Management, Inc. 1997)
RASS	Remedial action subsite
SUF	Site use factor

Source:

EPA. 1999. "Screening-Level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

PRC Environmental Management, Inc. 1997. "Qualitative Ecological Assessment, Litigation Area, Naval Weapons Station, Concord, California." September.

TABLE 88

SUMMARY OF THE APPROACH USED TO ESTIMATE RISK TO BIRDS AND MAMMALS FROM INORGANIC CHEMICALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Receptors Evaluated	Habitat Unit for Exposure Evaluation
California Black Rail	Slough (Units 9, 10, and 11)
Suisun Song Sparrow	Slough (Units 9, 10, and 11)
Mallard	RASS 3 Pond (Unit 13) and Slough (Units 9, 10, and 11)
Great Blue Heron	Pond (Unit 13) and Slough (Units 9, 10, and 11)
American Kestrel	RASSs 1 through 3 (Units 1, 2, 4, 6, 12, 13 and 16), RASS 4 (Unit 14), Unit 8
Northern Harrier	RASSs 1 through 3 (Units 1, 2, 4, 6, 12, 13 and 16), RASS 4 (Unit 14), Unit 8
Salt marsh harvest mouse	Marsh surface (Units 1, 2, 4, 6, and 8)
Gray fox	RASSs 1 through 3 (Units 1, 2, 4, 6, 12, 13 and 16), RASS 4 (Unit 14), Unit 8
River otter	Slough (Units 9, 10, and 11)

Parameter	Adult	Units	Reference/Notes
All Receptors			
Ingestion $Rate_{prey}$	Typical	kg/day	Literature value; if no literature ingestion rate value was available, calculated with body weight using the Nagy and others (1999) metabolic rate equation
Ingestion $Rate_{sediment/soil}$	Typical	kg/day	Literature-based rate
SUF	Typical	unitless	Based on literature-derived foraging range information
Body Weight	Typical	kg	Body weights from the literature; salt marsh harvest mouse body weights are site-specific
Threatened or Endangered Species (Black Rail and Salt Marsh Harvest Mouse)			
Prey Concentration	Maximum	mg/kg	Site-collected tissue
Sediment and Soil Concentrations	99th Percentile of the mean	mg/kg	Site-collected soil (1995 to 2000); 1/2 DL substituted for nondetects
Nonthreatened or Endangered Species – TIER 1			
Prey Concentration	UCL_{95} or Maximum	mg/kg	Site-collected plant, clam, fish, crayfish, tadpole, damselfly, and rodent tissue; UCL_{95}s used in dose for data sets with more than three samples (plant, clam, and rodents); maximums used for all other tissues
Sediment and Soil Concentrations	UCL_{95} of the grand mean	mg/kg	Site-collected soil (1995 to 2000); 1/2 DL substituted for nondetects
Nonthreatened or Endangered Species – TIER 2 (only for chemicals where $HQ_{(UCL95dose/High\ TRV)}$ is greater than 1.0)			
Prey Concentration	Mean	mg/kg	Site-collected tissue
Sediment/soil Concentrations	Mean	mg/kg	Site-collected soil (1995 to 2000); 1/2 DL substituted for nondetects

TABLE 88 (Continued)

SUMMARY OF THE APPROACH USED TO ESTIMATE RISK TO BIRDS AND MAMMALS FROM INORGANIC CHEMICALS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Notes:

1/2 DL	1/2 detection limit value
kg	Kilogram
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
ND	Nondetect
RASS	Remedial action subsite
SUF	Site use factor
UCL_{95}	95th percentile upper confidence limit of the mean (based on 5-year average concentration for each location)

Source:

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

TABLE 89

SUMMARY OF EXPOSURE PARAMETERS FOR THE BLACK RAIL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Dose Type	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	All	0.00578	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for all birds ($[10.5 \times (bw)^{0.681}]/18.0$ based on dry weight)
Sitewide sediment-to-amphipod BAF	Organic	DDT* = 0.95 PCB/Aroclors* = 0.53	unitless	The DDT BAF is based on the geometric mean of 13 values (Tubificidae, Chironomidae, and Croixidae) from Reich, Perkins, and Cutter (1986), as cited in EPA (1999) The Aroclor-1254 BAF is based on the geometric mean of two empirical values (*Chironomus tentans*) from Wood, O'Keefe, and Bush (1997), as cited in EPA (1999)
Prey Concentrations	Inorganic	UCL_{95} (clam) Maximum (amphipod)	mg/kg	Amphipod tissue collected in 1996; plant tissue collected in 1991; clam tissue collected in 1996 and 2000; 1/2 DL substituted for NDs
	Organic	Maximum sediment concentration x sitewide BAF (amphipod); Maximum (clam)	mg/kg	Sediment concentrations collected in ditch from 1995 to 2000; clams collected in 1996; totals summed using 1/2 DL and full DL as a substitute for NDs
Ingestion $Rate_{sediment}$	All	0.000104	kg/day	18 percent of ingestion rate; rate for sandpiper in Beyer and others (1994).
Sediment Concentrations	Inorganic	UCL_{95} slough concentration	mg/kg	Sediment collected from site from 1995 to 2000; 1/2 DL substituted for NDs
	Organic	Maximum ditch concentration	mg/kg	Sediment collected from site from 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
SUF	All	1	unitless	Based on foraging range information (120 hectares) from Zeiner (1990)
Body Weight	All	0.029	kg	Eddleman and others (1994)

TABLE 89 (Continued)

SUMMARY OF EXPOSURE PARAMETERS FOR THE BLACK RAIL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

*	Dichlorodiphenyldichloroethene was used as a surrogate for a total DDT BAF; Aroclor-1254 was used as a surrogate for a total PCB and total Aroclor BAF.
1/2 DL	1/2 Detection limit value
BAF	Bioaccumulation factor (tissue concentration/soil concentration = BAF)
bw	Body weight
DDT	Dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
full DL	Full detection limit value
kg	Kilogram
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
ND	Nondetect
PCB	Polychlorinated biphenyl
SUF	Site use factor
UCL_{95}	95th percentile upper confidence limit of the mean

Source:

Beyer, W.N., G.H. Heinz, and A.W. Redmon-Norwood. 1996. *Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations*. Lewis Publishers. Boca Raton, Florida.

Eddleman, W.R., R.E. Flores, and M.L. Legare. 1994. "Black Rail." *The Birds of North America*. Volume 123. Pages 1-20.

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EPA. 1999. "Screening-Level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.

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TABLE 90

SUMMARY OF EXPOSURE PARAMETERS FOR THE SUISUN SONG SPARROW
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	0.0048	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for passerines ($[10.5 \times (bw)^{0.681}]/18.7$ based on dry weight)
Prey Concentrations - Plants	UCL_{95}	mg/kg	Bulrush and pickleweed data collected from site in 1991
Prey Concentrations – Amphipods	Maximum	mg/kg	Amphipod data collected from the site in 1996 (three samples)
Ingestion $Rate_{sediment}$	0.00384	kg/day	8 percent of prey ingestion rate for sparrows, from Williams (1987)
Sediment Concentrations	UCL_{95} for marsh surface (Units 1, 2, 4, 6, 8, and 12)	mg/kg	Sediment collected from site from 1995 to 2000; 1/2 DL substituted for NDs
Territory Size	0.1	acre	Territory size of a salt marsh song sparrow based on Johntson (1968)
SUF	1	unitless	Based on territory size information
Body Weight	0.0235	kg	Dunning (1993)

Notes: No organic chemical doses were calculated for the Suisun song sparrow

1/2 DL 1/2 detection limit value
bw Body weight
kg Kilogram
kg/day Kilogram per day
mg/kg Milligram per kilogram
ND Nondetect
SUF Site use factor
UCL_{95} 95th Percentile upper confidence limit of the mean

Source:

Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.

Johnston, R.F. 1968. "Song Sparrow: San Francisco Bay Marsh Subspecies." *U.S. National Museum Bulletin 237*. Pages 1,547-1,553.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

Williams, J.B. 1987. "Field Metabolism and Food Consumption of Savannah Sparrows During the Breeding Season." *Auk*. Volume 104. Pages 277-289.

TABLE 91

SUMMARY OF EXPOSURE PARAMETERS FOR THE MALLARD
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Dose Type	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	All	0.0917	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for all birds and the food requirement conversion for omnivores ($[10.5 \times (bw)^{0681}]/14$ based on dry weight)
Sediment to Plant BAF	Organic	Total DDT* = 0.00937 Total PCB/Aroclors* = 0.01	unitless	The DDT BAF is based on the following regression equation: log BAF - 1.588-0578 × log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.015 (EPA 1994b), as cited in EPA (1999) The total PCBs and Aroclor BAF is based on the following regression equation: log BAF = 1.588-0.578 × log K_{ow} (Travis and Arms 1988), as cited in EPA (1999)
Plant Tissue Concentrations	Organic	BAF × maximum sediment concentration	mg/kg	Oatgrass, Mediterranean barley, Baltic rush, perennial ryegrass, and Olney bulrush tissue data collected from site in 1991; sediment collected from the site during 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Oatgrass, Mediterranean barley, Baltic rush, perennial ryegrass, and Olney bulrush tissue data collected from site in 1991
Fish, Amphipod, Damselfly, and Tadpole Tissue Concentrations	All	Maximum	mg/kg	Site-collected tissues from 1996; sculpin and stickleback tissue data collected from the slough and pond
Ingestion $Rate_{sediment}$	All	0.00302	kg/day	3.3 percent of ingestion rate; Mallard data from Beyer and others (1994)

TABLE 91 (Continued)

SUMMARY OF EXPOSURE PARAMETERS FOR THE MALLARD
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Dose Type	Average Adult	Units	Reference/Notes
Pond and Slough Sediment Concentrations	Organic	Maximum	mg/kg	Sediment collected from RASS 3 pond or slough; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Sediment collected from RASS 3 pond or slough; 1/2 DL substituted for NDs
Foraging Range	All	700-1,900	acres	Breeding home range of males and females in Minnesota forests from Gilmer and others (1975), as cited in Zeiner (1990).
SUF	All	1.0	unitless	Based on foraging range information for a laying duck.
Body Weight	All	1.161	kg	Average calculated from Heitmeyer (1988a) and Nelson and Martin (1953), both as cited in EPA (1993)

Notes:

* BAFs for 4,4'-dichlorodiphenyldichloroethene and Aroclor 1254 were used as total DDT and total PCB BAFs.

1/2 DL 1/2 detection limit value
BAF Bioaccumulation factor (tissue concentration/sediment concentration = BAF)
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
full DL Full detection limit value
kg/day Kilogram per day
mg/kg Milligram per kilogram
ND Nondetect
Maximum Maximum of grand mean from 5 years of monitoring
kg Kilogram
RASS Remedial action subsite
SUF Site use factor
UCL_{95} 95th Percentile upper confidence limit of the mean

Source:

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." *Journal of Wildlife Management.* Volume 58. Pages 375-382.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.

EPA. 1999. "Screening-Level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White. 1990. *California's Wildlife.* Volumes 1, 2, and 3. California Statewide Wildlife Habitat Relationships System, Department of Fish and Game. Sacramento, California.

TABLE 92

SUMMARY OF EXPOSURE PARAMETERS FOR THE GREAT BLUE HERON
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Dose Type	Typical Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	All	0.1295	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for all birds and the food requirement conversion for fish-eating birds ($[10.5 \times (bw)^{0.681}]/16.2$ based on dry weight)
Soil to rodent BAF	Organic	DDT = 8.06e-05 PCBs = 7.20e-05	unitless	4,4'DDE and Aroclor-1254 BAFs from EPA (1999)
Aquatic Prey Concentrations	All	Maximum	mg/kg	Stickleback, crayfish, tadpole, and sculpin tissue data collected at the site in 1996; 1/2 DL substituted for NDs
Terrestrial Prey Concentrations	Organic	BAF × maximum sediment concentration	mg/kg	BAF from EPA (1999); sediment collected from site from 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Rodent tissue data collected from site in 1991; 1/2 DL substituted for NDs.
Tissue Moisture	All	68 (mouse) 85 (amphibian)	Percent	Mouse and frogs and toads tissue moisture from EPA (1993)
Ingestion $Rate_{sediment}$	All	0.0042735	kg/day	3.3 percent of ingestion rate; based on Mallard data from Beyer and others (1994)
Sediment Concentrations	Organic	Maximum	mg/kg	Sediment collected from site from 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Sediment collected from site from 1995 to 2000; 1/2 DL substituted for NDs
Foraging Range	All	1.5 to 20.8	acres	Size of feeding territory in an Oregon freshwater marsh and estuary from Bayer (1978), as cited in EPA (1993)
SUF – Slough doses	All	1	unitless	Based on foraging range information
SUF – Pond doses	All	0.5	unitless	Based on foraging range information
Body Weight	All	2.39	kg	Average calculated from Dunning (1993)

Notes:

1/2 DL	1/2 detection limit value	kg/day	Kilogram per day
BAF	Bioaccumulation factor	mg/kg	Milligram per kilogram
bw	Body weight	ND	Nondetect
EPA	U.S. Environmental Protection Agency	SUF	Site use factor
full DL	Full detection limit value	UCL_{95}	One-sided 95 percent upper confidence limit of the mean
kg	Kilogram		

TABLE 92 (Continued)

SUMMARY OF EXPOSURE PARAMETERS FOR THE GREAT BLUE HERON
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Source:

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." *Journal of Wildlife Management.* Volume 58. Pages 375-382.

Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

EPA 1999. "Screening-Level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.

EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.

TABLE 93

SUMMARY OF EXPOSURE PARAMETERS FOR THE AMERICAN KESTREL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	0.0151	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for all birds ($[10.5 \times (bw)^{0.681}]/18.0$ based on dry weight)
Prey Concentrations	UCL_{95}	mg/kg	Rodent kidney and liver tissue data collected from site in 1991
Ingestion $Rate_{soil}$	0.0001057	kg/day	0.7 percent of ingestion rate; rate for Bald Eagle in Pascoe and others (1996)
Soil Concentrations	UCL_{95}	mg/kg	Soil collected from RASSs 1 through 3, RASS 4, and Unit 8 from 1995 to 2000; 1/2 DL substituted for NDs
Home Range	109.4	hectares	Home range of American kestrels from Balgooyen (1976)
SUF	RASS 1-3 = 1 RASS 4 = 0.1 Unit 8 = 0.1	unitless	Based on foraging range information; RASSs 1 through 3 is 119 ha, RASS 4 is 5.3 ha, and Unit 8 is 7.6 ha
Body Weight	0.119	kg	Average from Roest (1957)

Notes: No organic chemical doses were calculated for the American kestrel

1/2 DL One-half detection limit value
bw Body weight
ha Hectare
kg Kilogram
kg/day Kilogram per day
mg/kg Milligram per kilogram
ND Nondetect
RASS Remedial action subsite
SUF Site use factor
UCL_{95} One-sided 95 percent upper confidence limit of the mean

Source:

Balgooyen, T.G. 1976. "Behavior and Ecology of the American Kestrel in the Sierra Nevada of California." *University of California Publ. Zool.* Volume 103.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. "Food-chain Analysis of Exposures and Risks to Wildlife at a Metals-contaminated Wetland." *Archives of Environmental Contamination and Toxicology.* Volume 30. Pages 306-318.

Roest, A.I. 1957. "Notes on the American Sparrow Hawk." *Auk*. Volume 74. Number 1. Pages 1-19.

TABLE 94

SUMMARY OF EXPOSURE PARAMETERS FOR THE NORTHERN HARRIER FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Parameter	Dose Type	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	All	0.0369	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for all birds ($[10.5 \times (bw)^{0681}]/18.0$ based on dry weight)
Soil to rodent BAF	Organic	DDT = 8.06e-05 PCBs = 7.20e-05	unitless	4,4'-DDE and Aroclor-1254 BAFs from EPA (1999)
Prey Concentrations	Organic	Maximum soil concentration × BAF	mg/kg	Soil concentrations collected from 1995 to 2000; BAF from EPA (1999); totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Rodent kidney and liver tissue data collected from site in 1991
Tissue Moisture	All	68	Percent	Mouse tissue moisture from EPA (1993)
Ingestion $Rate_{soil}$	All	0.0002583	kg/day	0.7 percent of ingestion rate; rate for Bald Eagle in Pascoe and others (1996)
Soil Concentrations	Organic	Maximum	mg/kg	Soil collected at the site from 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Soil collected at the site from 1995 to 2000; 1/2 DL substituted for NDs
Foraging Range	All	12-259	hectares	Daily foraging area in Michigan from Craighead and Craighead (1956), as cited in Zeiner (1990)
	All	405	hectares	Home range of 15 breeding pairs in Michigan from Craighead and Craighead (1956), as cited in Zeiner (1990)
SUF	All	RASS 1-3 = 1.0 RASS 4 = 0.1 Unit 8 = 0.1	unitless	Based on foraging range information and size of area; RASSs 1 through 3 is 119 ha, RASS 4 is 5.3 ha, and Unit 8 is 7.6 ha
Body Weight	All	0.441	kg	Average of males and females from Dunning (1993)

Notes:

1/2 DL	One-half detection limit value	mg/kg	Milligrams per kilogram
bw	Body weight	Maximum	Maximum of grand mean from 5 years of monitoring
EPA	U.S. Environmental Protection Agency	ND	Nondetect
full DL	Full detection limit value	RASS	Remedial action subsite
ha	Hectare	SUF	Site use factor
kg	Kilogram	UCL_{95}	One-sided 95 percent upper confidence limit of the mean
kg/day	Kilograms per day		

TABLE 94 (Continued)

SUMMARY OF EXPOSURE PARAMETERS FOR THE NORTHERN HARRIER FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Source:

Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. "Food-chain Analysis of Exposures and Risks to Wildlife at a Metals-contaminated Wetland." *Archives of Environmental Contamination and Toxicology.* Volume 30. Pages 306-318.

EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.

EPA. 1999. "Screening-Level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White. 1990. *California's Wildlife.* Volumes 1, 2, and 3. California Statewide Wildlife Habitat Relationships System, Department of Fish and Game. Sacramento, California.

TABLE 95

SUMMARY OF EXPOSURE PARAMETERS FOR THE SALT MARSH HARVEST MOUSE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Dose Type	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	All	0.002646	kg/day	From Fisler (1963), as listed in the California Department of Toxic Substances Control Wildlife Exposure Factor and Toxicity Database (http://www.oehha.org/cal_ecotox/); (0.245 g/g-day; 0.245 × BW = kg/day)
Sitewide Sediment-to-Plant BAF	Organic	Total DDTs* = 0.00937 Total PCBs/Aroclors* = 0.01	unitless	The DDT BAF is based on the following regression equation: log BCF - 1.588-0578 × log Kow (Travis and Arms 1988), where log Kow = 5.015 (EPA 1994b), both as cited in EPA (1999). The total PCBs and Aroclor BAF is based on the following regression equation: log BCF = 1.588-0.578 × log K_{ow} (Travis and Arms 1988), as cited in EPA (1999)
Prey Concentrations	Organic	Maximum soil concentration × sitewide BAF	mg/kg	BAF from EPA (1999), as described above; soil concentrations collected from 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	Maximum	mg/kg	Pickleweed tissue data collected from site in 1991 and 1995
Ingestion $Rate_{soil}$	All	0.0000635	kg/day	2.4 percent of ingestion rate; meadow vole data from Beyer and others (1994)
Soil Concentrations	Organic	Maximum	mg/kg	Soil data collected from site from Units 1, 2, 4, 6, and 8 during 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	99th Percentile	mg/kg	Soil data collected from site from Units 1, 2, 4, 6, and 8 during 1995 to 2000; 1/2 DL substituted for NDs
Foraging Range	All	0.40 to 0.64	acres	From Golley and others (1975)
SUF	All	1.0	unitless	Based on foraging range information
Body Weight	All	0.0108	kg	Site collected data from Litigation Area baseline conditions report (PRC 1994)

TABLE 95 (Continued)

SUMMARY OF EXPOSURE PARAMETERS FOR THE SALT MARSH HARVEST MOUSE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

*	BAFs for 4,4'-dichlorodiphenyldichloroethene and Aroclor-1254 were used as total DDTs and total PCBs BAFs.
1/2 DL	One-half detection limit value
99th Percentile	99th percentile of the data (nonparametric)
BAF	Bioaccumulation factor (tissue concentration/sediment concentration = BAF)
BW	Body weight
EPA	U.S. Environmental Protection Agency
full DL	Full detection limit
kg	Kilogram
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
Maximum	Maximum of grand mean from 5 years of monitoring
ND	Nondetect
PCB	Polychlorinated biphenyl
PRC	PRC Environmental Management, Inc.
SUF	Site use factor

Source:

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." *Journal of Wildlife Management.* Volume 58. Pages 375-382.
EPA. 1999. "Screening-Level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Golley, F.B., K. Petrusewicz, and L. Ryskowski (Editors). 1975. *Small Mammals: Their Productivity and Population Dynamics.* Cambridge University Press. New York, New York.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.
PRC. 1994. "Draft Baseline Conditions Report, Litigation Area Sites, Naval Weapons Station Concord, California." February 14.

TABLE 96

SUMMARY OF EXPOSURE PARAMETERS FOR THE GRAY FOX
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	0.177	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for eutherian mammals, and the food requirement conversion for omnivores ($[4.21 \times (bw)^{0.772}]/14.0$ based on dry weight)
Prey Concentrations	UCL_{95}	mg/kg	Rodent tissue data collected from site in 1991
Ingestion $Rate_{soil}$	0.00496	kg/day	2.8 percent of ingestion rate; rate for red fox in Beyer and others (1994)
Soil Concentrations	UCL_{95}	mg/kg	Soil collected in RASSs 1 through 3, RASS 4, and Unit 8 during 1995 to 2000; 1/2 DL substituted for NDs.
Foraging range	120	hectares	Average home range from Zeiner (1990)
SUF	0.25	unitless	Based on foraging range information
Body Weight	4.4	kg	Average of males and females from Silva and Downing (1995)

Notes: No organic doses were calculated for the gray fox

1/2 DL One-half detection limit value
bw Body weight
kg Kilogram
kg/day Kilogram per day
mg/kg Milligram per kilogram
ND Nondetect
RASS Remedial action subsite
SUF Site use factor
UCL_{95} One-sided 95 percent upper confidence limit of the mean

Source:

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." *Journal of Wildlife Management.* Volume 58. Pages 375-382.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

Silva, M., and J.A. Downing. 1995. *CRC Handbook of Mammalian Body Masses*. CRC Press. Boca Raton, Florida.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White. 1990. *California's Wildlife.* Volumes 1, 2, and 3. California Statewide Wildlife Habitat Relationships System, Department of Fish and Game. Sacramento, California.

TABLE 97

SUMMARY OF EXPOSURE PARAMETERS FOR THE RIVER OTTER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Parameter	Dose Type	Average Adult	Units	Reference/Notes
Ingestion $Rate_{prey}$	All	0.215	kg/day	Calculated with body weight using the Nagy and others (1999) metabolic rate equation for eutherian mammals, and the food requirement conversion for carnivores ($[4.21 \times (bw)^{0.772}]/14.0$ based on dry weight)
Prey Concentrations	Organic	Maximum	mg/kg	Clam tissue data collected from site in 1996 and 2000; fish tissue data collected from site in 1996; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Clam tissue data collected from site in 1996 and 2000; fish tissue data collected from site in 1996; 1/2 DL substituted for NDs
Ingestion $Rate_{sediment}$	All	0.00215	kg/day	1 percent of ingestion rate; rate for mink in Pascoe and others (1996)
Sediment Concentrations	Organic	Maximum	mg/kg	Sediment collected from slough in 1995 to 2000; totals summed using 1/2 DL and full DL as a substitute for NDs
	Inorganic	UCL_{95}	mg/kg	Sediment collected from slough in 1995 to 2000; 1/2 DL substituted for NDs
Foraging range	All	323	hectares	Average home range from Foy (1982), as cited in Zeiner (1990)
SUF	All	0.25	unitless	Based on foraging range information
Body Weight	All	5.0	kg	Based on EPA (1993)

Notes:

1/2 DL	One-half detection limit value	mg/kg	Milligram per kilogram
bw	Body weight	Maximum	Maximum of grand mean from 5 years of monitoring
EPA	U.S. Environmental Protection Agency	ND	Nondetect
Full DL	Full detection limit value	SUF	Site use factor
kg	Kilogram	UCL_{95}	One-sided 95 percent upper confidence limit of the mean
kg/day	Kilogram per day		

Source:

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-Ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. "Food-chain Analysis of Exposures and Risks to Wildlife at a Metals-contaminated Wetland." *Archives of Environmental Contamination and Toxicology.* Volume 30. Pages 306-318.

EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White. 1990. *California's Wildlife.* Volumes 1, 2, and 3. California Statewide Wildlife Habitat Relationships System, Department of Fish and Game. Sacramento, California.

TABLE 98

SUMMARY OF HAZARD QUOTIENTS FOR THE BLACK RAIL FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

A. ORGANIC CHEMICALS

Chemical	Location[a]	1/2 DL Dose (mg/kg-day)	Full Dose (mg/kg-day)	Low TRV[b] (mg/kg-day)	High TRV[b] (mg/kg-day)	HQ_{full} (Full dose/ High TRV)	$HQ_{/2DL}$ (1/2 DL dose/ High TRV)	HQ_{full} (Full dose/ Low TRV)	$HQ_{1/2DL}$ (1/2 DL dose/ Low TRV)
100% Amphipod Diet [c]									
Total DDTs	Ditches	0.05	0.10	0.003	0.74	0.14	0.07	**29.68**	**14.84**
PCB/Aroclors	Ditches	0.78	1.56	0.04	0.65	**2.38**	**1.19**	**36.89**	**18.45**
100% Clam Diet [c]									
Total DDTs	Ditches	0.01	0.02	0.003	0.74	0.03	0.01	**6.81**	**2.33**
PCBs and Aroclors	Ditches	0.05	0.12	0.04	0.65	0.19	0.08	**2.93**	**1.19**

A. INORGANIC CHEMICALS

Chemical	Location[a]	Dose Type	Dose[d] (mg/kg-day)	Low TRV[b] (mg/kg-day)	High TRV[b] (mg/kg-day)	HQ (Dose/ High TRV)	HQ (Dose/ Low TRV)
100% Amphipod Diet [c]							
Arsenic	Main Slough	Max	12.00	2.62	10.50	**1.14**	**4.57**
Cadmium	Main Slough	Max	9.01	0.04	8.43	**1.07**	**218.70**
Copper	Main Slough	Max	52.79	1.24	30.78	**1.71**	**42.60**
Lead	Main Slough	Max	6.43	0.01	4.51	**1.43**	**568.53**
Mercury	Main Slough	Max	0.06	0.02	0.09	0.69	**3.18**
Selenium	Main Slough	Max	0.28	0.11	0.45	0.62	**2.52**
Zinc	Main Slough	Max	1,084.87	8.55	85.51	**12.69**	**126.87**

Notes: **Bold** values indicate HQ is greater than 1.0.

a For organic chemicals, ditch data were used; for inorganic chemicals, doses were calculated for the main slough.

b Low and High TRV calculated as described in Section 6.0 of Appendix G.

c Diet composition based on literature reviews and available data as described in Section 6.0 of Appendix G.

d Estimated dose calculated as described in Section 6.0 of Appendix G.

1/2 DL Dose One-half the detection limit was substituted for nondetects.

DDT Dichlorodiphenyltrichloroethane

Full DL Dose The full detection limit was substituted for nondetects.

HQ Hazard quotient

mg/kg-day Milligrams per kilogram per day

Max Doses calculated using 99th percentile sediment concentration and maximum tissue concentration with exposure parameters for a typical receptor.

TRV Toxicity reference value

TABLE 99

SUMMARY OF HAZARD QUOTIENTS FOR THE SUISUN SONG SPARROW
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Location[a]	Dose Type[b]	Dose[c] (mg/kg-day)	Low TRV[d] (mg/kg-day)	High TRV[d] (mg/kg-day)	HQ (Dose/ High TRV)	HQ (Dose/ Low TRV)
50% Plant, 50% Amphipod Diet [e]							
Arsenic	Slough	UCL_{95}	7.82	2.52	10.07	0.78	**3.11**
Cadmium	Slough	UCL_{95}	0.46	0.04	8.08	0.06	**11.52**
Copper	Slough	UCL_{95}	23.55	1.19	29.51	0.80	**19.82**
Lead	Slough	UCL_{95}	2.95	0.01	4.32	0.68	**272.05**
Mercury	Slough	UCL_{95}	0.02	0.02	0.09	0.25	**1.17**
Selenium	Slough	UCL_{95}	1.55	0.11	0.43	**3.60**	**14.55**
	Slough	Mean	1.08	0.11	0.43	**2.51**	NC
Zinc	Slough	UCL_{95}	56.20	8.20	81.99	0.69	**6.85**
100% Amphipod Diet [e]							
Arsenic	Slough	UCL_{95}	3.91	2.52	10.07	0.39	**1.55**
Cadmium	Slough	UCL_{95}	0.31	0.04	8.08	0.04	**7.78**
Copper	Slough	UCL_{95}	41.21	1.19	29.51	**1.40**	**34.69**
	Slough	Mean	37.20	1.19	29.51	**1.26**	NC
Lead	Slough	UCL_{95}	3.42	0.01	4.32	0.79	**314.82**
Mercury	Slough	UCL_{95}	0.04	0.02	0.09	0.43	**1.99**
Selenium	Slough	UCL_{95}	0.16	0.11	0.43	0.37	**1.48**
Zinc	Slough	UCL_{95}	91.09	8.20	81.99	**1.11**	**11.11**
	Slough	Mean	77.77	8.20	81.99	0.95	NC

Notes: **Bold** values indicate HQ is greater than 1.0.

a Data from the the main slough were used.

b UCL_{95} dose calculated using UCL_{95} sediment and UCL_{95} or maximum tissue concentration with exposure parameters for a typical receptor.
Mean dose calculated using the mean sediment concentration and mean tissue concentration with exposure exposure parameters for a typical receptor; only calculated when UCL_{95} dose exceeded the high TRV.

c Low and High Dose were calculated as described in Section 6.0 of Appendix G.

d Low and High TRV calculated as described in Section 6.0 of Appendix G.

e Diet composition based on literature reviews and available data as described in Section 6.0 of Appendix G.

HQ Hazard quotient
mg/kg-day Milligrams per kilogram per day
NC Not calculated
TRV Toxicity reference value
UCL_{95} One-side 95 percent upper confidence limit of the mean

TABLE 100

SUMMARY OF HAZARD QUOTIENTS FOR THE MALLARD
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

A. ORGANIC CHEMICALS

Chemical	Model[a]	1/2 DL dose (mg/kg-day)	Full DL dose (mg/kg-day)	Low TRV[b] (mg/kg-day)	High TRV[b] (mg/kg-day)	$HQ_{Full\ DL}$ (Full dose/ High TRV)	$HQ_{1/2DL}$ (1/2 DL Dose/ High TRV)	$HQ_{Full\ DL}$ (Full dose/ Low TRV)	$HQ_{1/2DL}$ (1/2 DL Dose/ Low TRV)
50% Damselfly Larvae, 12.5% Stickleback, 12.5% Tadpoles, and 25% Plants [c]									
Total DDTs	Pond	0.01	0.01	0.01	1.55	0.01	0.005	**1.58**	0.98
PCBs/Aroclors	Pond	0.02	0.04	0.10	1.17	0.03	0.02	0.37	0.21
75% Amphipods and 25% Sculpins[c]									
Total DDTs	Slough	0.01	0.03	0.01	1.55	0.02	0.01	**3.70**	**1.92**
PCBs/Aroclors	Slough	0.19	0.38	0.10	1.17	0.33	0.16	**3.96**	**1.99**

B. INORGANIC CHEMICALS

Chemical	Model[a]	UCL_{95} Dose[d] (mg/kg-day)	Low TRV[b] (mg/kg-day)	High TRV[b] (mg/kg-day)	HQ (Dose/ High TRV)	HQ (Dose/ Low TRV)
50% Damselfly Larvae, 12.5% Stickleback, 12.5% Tadpoles, and 25% Plants [c]						
Arsenic	Pond	0.73	5.49	21.97	0.03	0.03
Cadmium	Pond	0.16	0.09	17.64	0.01	**1.87**
Copper	Pond	1.48	2.59	64.39	0.02	0.57
Lead	Pond	0.61	0.02	9.43	0.06	**25.71**
Mercury	Pond	0.01	0.04	0.19	0.04	0.16
Selenium	Pond	0.68	0.23	0.94	0.72	**2.92**
Zinc	Pond	25.43	17.89	178.85	0.14	**1.42**
75% Amphipods and 25% Sculpins[c]						
Arsenic	Slough	0.72	5.49	21.97	0.03	0.13
Cadmium	Slough	0.13	0.09	17.64	0.01	**1.56**
Copper	Slough	11.90	2.59	64.39	0.18	**4.59**
Lead	Slough	0.50	0.02	9.43	0.05	**21.23**
Mercury	Slough	0.01	0.04	0.19	0.07	0.31
Selenium	Slough	0.05	0.23	0.94	0.06	0.23
Zinc	Slough	30.35	17.89	178.85	0.17	**1.70**

Notes: **Bold** values indicate HQ is greater than 1.0.

a Data from the RASS 3 pond (Pond) and main slough were used to calculate doses.

b Low and High TRV calculated as described in Section 6.0 of Appendix G.

c Diet composition based on literature reviews and available data as described in Section 6.0 of Appendix G.

d UCL_{95} dose calculated as described in Section 6.0 of Appendix G.

1/2 DL Dose One-half the detection limit was substituted for nondetects.
DDT Dichlorodiphenyltrichloroethane
Full DL Dose The full detection limit was substituted for nondetects.
HQ Hazard quotient
mg/kg-day Milligrams per kilogram per day
PCB Polychlorinated biphenyl
TRV Toxicity reference value
UCL_{95} One-side 95 percent upper confidence limit

TABLE 101

SUMMARY OF HAZARD QUOTIENTS FOR THE GREAT BLUE HERON
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

A. ORGANIC CHEMICALS

Chemical	Location[a]	1/2 DL Dose (mg/kg-day)	Full Dose (mg/kg-day)	Low TRV[b] (mg/kg-day)	High TRV[b] (mg/kg-day)	$HQ_{Full\ DL}$ (Full dose/ High TRV)	$HQ_{1/2DL}$ (1/2 DL dose/ High TRV)	$HQ_{Full\ DL}$ (Full dose/ Low TRV)	$HQ_{1/2DL}$ (1/2 DL dose/ Low TRV)
80% Stickleback, 15% Crayfish, and 5% Tadpoles[c]									
Total DDTs	Pond	0.003	0.003	0.01	1.79	0.002	0.002	0.36	0.36
PCBs/Aroclors	Pond	0.01	0.01	0.11	1.36	0.01	0.004	0.07	0.05
100% Fish [c]									
Total DDTs	Slough	0.002	0.003	0.01	1.79	0.002	0.001	0.36	0.24
PCBs/Aroclors	Slough	0.01	0.01	0.11	1.36	0.01	0.005	0.09	0.06

B. INORGANIC CHEMICALS

Chemical	Location[a]	UCL_{95} Dose[d] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV_c (mg/kg-day)	HQ (Dose/ High TRV)	HQ (Dose/ Low TRV)
80% Stickleback, 10% Crayfish, 10% Tadpoles, and 5% Rodents[b]						
Arsenic	Pond	0.07	6.34	25.38	0.003	0.01
Cadmium	Pond	0.02	0.10	20.38	0.001	0.16
Copper	Pond	0.66	2.99	74.39	0.01	0.22
Lead	Pond	0.15	0.03	10.89	0.01	**5.49**
Mercury	Pond	0.004	0.05	0.21	0.02	0.09
Selenium	Pond	0.10	0.27	1.08	0.09	0.36
Zinc	Pond	8.97	20.66	206.64	0.04	0.10
100% Fish [b]						
Arsenic	Slough	0.21	6.34	25.38	0.01	0.03
Cadmium	Slough	0.04	0.10	20.38	0.002	0.44
Copper	Slough	1.53	2.99	74.39	0.02	0.51
Lead	Slough	0.10	0.03	10.89	0.01	**3.56**
Mercury	Slough	0.01	0.05	0.21	0.03	0.16
Selenium	Slough	0.03	0.27	1.08	0.03	0.11
Zinc	Slough	5.16	20.66	206.64	0.02	0.25

Notes: **Bold** values indicate HQ is greater than 1.0.
a Data from the RASS 3 pond (Pond) and slough were used to calculate doses.
b Low and High TRV calculated as described in Section 6.0 of Appendix G.
c Diet composition based on literature reviews and available data as described in Section 6.0 of Appendix G.
d UCL_{95} dose calculated as described in Section 6.0 of Appendix G.

1/2 DL Dose One-half the detection limit was substituted for nondetects.
DDT Dichlorodiphenyltrichloroethane
Full DL Dose The full detection limit was substituted for nondetects.
HQ Hazard quotient
mg/kg-day Milligrams per kilogram per day
TRV Toxicity reference value
UCL_{95} One-side 95 percent upper confidence limit

TABLE 102

SUMMARY OF HAZARD QUOTIENTS FOR THE AMERICAN KESTREL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Model[a]	Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ (dose/ high TRV)	HQ (dose/ Low TRV)
Arsenic	RASS 1-3	0.27	3.48	13.93	0.02	0.08
	RASS 4	0.02	3.48	13.93	0.001	0.005
	Unit 8	0.02	3.48	13.93	0.001	0.01
Cadmium	RASS 1-3	0.21	0.05	11.18	0.02	**3.77**
	RASS 4	0.01	0.05	11.18	0.001	0.26
	Unit 8	0.02	0.05	11.18	0.002	0.34
Copper	RASS 1-3	3.61	1.64	40.83	0.09	**2.20**
	RASS 4	0.41	1.64	40.83	0.01	0.25
	Unit 8	0.36	1.64	40.83	0.01	0.22
Lead	RASS 1-3	0.54	0.02	5.98	0.09	**36.14**
	RASS 4	0.08	0.02	5.98	0.01	**5.13**
	Unit 8	0.05	0.02	5.98	0.01	**3.12**
Selenium	RASS 1-3	0.44	0.15	0.60	0.73	**2.97**
	RASS 4	0.10	0.15	0.60	0.16	0.65
	Unit 8	0.05	0.15	0.60	0.08	0.33
Zinc	RASS 1-3	10.68	11.34	113.41	0.09	0.94
	RASS 4	1.33	11.34	113.41	0.01	0.12
	Unit 8	1.34	11.34	113.41	0.01	0.12

Notes: **Bold** values indicate HQ is greater than 1.0.
a Dose model described in Section 6.0 of Appendix G.
b Doses calculated for RASSs 1 through 3, RASS 4, and Unit 8, as described in Section 6.0 of Appendix G.
c Low and High Dose were calculated as described in Section 6.0 of Appendix G.

HQ Hazard quotient
mg/kg-day Milligrams per kilogram per day
RASS Remedial action subsite
TRV Toxicity reference value

TABLE 103

SUMMARY OF HAZARD QUOTIENTS FOR THE NORTHERN HARRIER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

A. ORGANIC CHEMICALS

Chemical	Model[a]	1/2 DL Dose[b] (mg/kg-day)	Full Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	$HQ_{Full\ DL}$ (Full dose/ High TRV)	$HQ_{1/2DL}$ (1/2 DL dose/ High TRV)	$HQ_{Full\ DL}$ (Full dose/ Low TRV)	$HQ_{1/2DL}$ (1/2 DL dose/ Low TRV)
Total DDTs	RASS 3&4 Upland	0.00002	0.00002	0.01	1.27	0.00002	0.00002	0.004	0.004
PCBs/Aroclors	RASS 3&4 Upland	0.001	0.001	0.07	1.13	0.001	0.001	0.01	0.01

B. INORGANIC CHEMICALS

Chemical	Model[a]	95 UCL Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ (Dose/ High TRV)	HQ (Dose/ Low TRV)
Arsenic	RASS 1-3	0.18	4.52	18.10	0.01	0.04
	RASS 4	0.01	4.52	18.10	0.001	0.002
	Unit 8	0.01	4.52	18.10	0.001	0.003
Cadmium	RASS 1-3	0.14	0.07	14.53	0.01	**1.91**
	RASS 4	0.01	0.07	14.53	0.001	0.13
	Unit 8	0.01	0.07	14.53	0.001	0.17
Copper	RASS 1-3	2.38	2.14	53.05	0.04	**1.11**
	RASS 4	0.27	2.14	53.05	0.01	0.13
	Unit 8	0.24	2.14	53.05	0.004	0.11
Lead	RASS 1-3	0.36	0.02	7.77	0.05	**18.34**
	RASS 4	0.05	0.02	7.77	0.01	**2.60**
	Unit 8	0.03	0.02	7.77	0.004	**1.58**
Selenium	RASS 1-3	0.29	0.19	0.77	0.37	**1.51**
	RASS 4	0.06	0.19	0.77	0.08	0.33
	Unit 8	0.03	0.19	0.77	0.04	0.17
Zinc	RASS 1-3	7.04	14.74	147.37	0.05	0.48
	RASS 4	0.88	14.74	147.37	0.01	0.06
	Unit 8	0.64	14.74	147.37	0.004	0.04

Notes: **Bold** values indicate HQ is greater than 1.0.
a Dose model described in Section 6.0 of Appendix G.
b Doses calculated for RASSs 1 through 3, RASS 4, and Unit 8, as described in Section 6.0 of Appendix G.
c Low and High Dose were calculated as described in Section 6.0 of Appendix G.

1/2 DL Dose One-half the detection limit was substituted for nondetects.
DDT Dichlorodiphenyltrichloroethane
Full DL Dose The full detection limit was substituted for nondetects.
HQ Hazard quotient
mg/kg-day Milligrams per kilogram per day
PCB Polychlorinated biphenyl
RASS Remedial action subsite
TRV Toxicity reference value
UCL_{95} One-side 95 percent upper confidence limit

TABLE 104

SUMMARY OF HAZARD QUOTIENTS FOR THE SALT MARSH HARVEST MOUSE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

A. ORGANIC CHEMICALS

Chemical	Location[a]	1/2 DL dose[b] (mg/kg-day)	Full dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ_{full} (Full dose/ Low TRV)
Total DDTs	Marsh Surface	0.001	0.002	0.98	19.61	0.002
PCBs/Aroclors	Marsh Surface	0.02	0.05	0.37	1.34	0.13

B. INORGANIC CHEMICALS

Chemical	Location[a]	Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ (Dose / high TRV)	HQ (Dose / Low TRV)
Arsenic	Unit 1	0.11	0.39	5.40	0.02	0.29
	Unit 2	0.46	0.39	5.40	0.08	**1.16**
	Unit 4	0.68	0.39	5.40	0.13	**1.74**
	Unit 6	6.03	0.39	5.40	**1.12**	**15.35**
	Unit 8	0.26	0.39	5.40	0.05	0.67
Cadmium	Unit 1	0.01	0.06	2.81	0.00	0.19
	Unit 2	0.005	0.06	2.81	0.00	0.08
	Unit 4	0.01	0.06	2.81	0.01	0.23
	Unit 6	0.09	0.06	2.81	0.03	**1.42**
	Unit 8	0.02	0.06	2.81	0.01	0.23
Copper	Unit 1	0.74	2.84	663.72	0.001	0.26
	Unit 2	0.90	2.84	663.72	0.001	0.32
	Unit 4	1.23	2.84	663.72	0.002	0.43
	Unit 6	5.65	2.84	663.72	0.01	**1.99**
	Unit 8	1.35	2.84	663.72	0.002	0.48
Lead	Unit 1	0.83	0.002	248.70	0.003	**462.75**
	Unit 2	0.59	0.002	248.70	0.002	**328.22**
	Unit 4	1.29	0.002	248.70	0.01	**720.90**
	Unit 6	2.70	0.002	248.70	0.01	**1508.57**
	Unit 8	0.66	0.002	248.70	0.003	**367.42**
Mercury	Unit 1	0.003	0.30	4.99	0.001	0.01
	Unit 2	0.01	0.30	4.99	0.001	0.02
	Unit 4	0.004	0.30	4.99	0.001	0.01
	Unit 6	0.01	0.30	4.99	0.001	0.02
	Unit 8	0.01	0.30	4.99	0.001	0.02
Selenium	Unit 1	0.03	0.06	1.27	0.03	0.57
	Unit 2	0.03	0.06	1.27	0.03	0.57
	Unit 4	0.04	0.06	1.27	0.03	0.63
	Unit 6	0.05	0.06	1.27	0.04	0.85
	Unit 8	0.03	0.06	1.27	0.03	0.57
Zinc	Unit 1	2.86	10.11	486.26	0.01	0.28
	Unit 2	3.67	10.11	486.26	0.01	0.36
	Unit 4	13.21	10.11	486.26	0.03	**1.31**
	Unit 6	32.28	10.11	486.26	0.07	**3.19**
	Unit 8	6.34	10.11	486.26	0.01	0.63

Notes:

a For organic chemicals, model based on soil or sediment from he marsh surface.
For inorganic chemicals, model based on soil or sediment from Units 1, 2, 4, 6, or 8.

b Doses calculated as described in Section 6.0 of Appendix G.

c Low and High Dose were calculated as described in Section 6.0 of Appendix G.

1/2 DL Dose	One-half the detection limit was substituted for nondetects
DDT	Dichlorodiphenyltrichloroethane
Full DL Dose	The full detection limit was substituted for nondetects.
HQ	Hazard quotient
mg/kg-day	Milligrams per kilogram per day
PCB	Polychlorinated biphenyl
RASS	Remedial action subsite
TRV	Toxicity reference value

TABLE 105

SUMMARY OF HAZARD QUOTIENTS FOR THE GRAY FOX
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Dose Type	Area[a]	Typical Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ (Typical Dose/ High TRV)	HQ (Typical Dose/ Low TRV)
Arsenic	UCL_{95}	RASS 1-3	0.04	0.28	3.80	0.01	0.16
	UCL_{95}	RASS 4	0.02	0.28	3.80	0.01	0.09
	UCL_{95}	Unit 8	0.02	0.28	3.80	0.01	0.07
Cadmium	UCL_{95}	RASS 1-3	0.02	0.05	1.98	0.01	0.40
	UCL_{95}	RASS 4	0.01	0.05	1.98	0.01	0.27
	UCL_{95}	Unit 8	0.02	0.05	1.98	0.01	0.36
Copper	UCL_{95}	RASS 1-3	0.32	1.99	466.29	0.001	0.16
	UCL_{95}	RASS 4	0.33	1.99	466.29	0.001	0.17
	UCL_{95}	Unit 8	0.34	1.99	466.29	0.001	0.17
Lead	UCL_{95}	RASS 1-3	0.06	0.001	174.72	0.0004	**50.60**
	UCL_{95}	RASS 4	0.16	0.001	174.72	0.001	**126.95**
	UCL_{95}	Unit 8	0.05	0.001	174.72	0.0003	**37.23**
Selenium	UCL_{95}	RASS 1-3	0.03	0.04	0.89	0.04	0.84
	UCL_{95}	RASS 4	0.09	0.04	0.89	0.10	**2.07**
	UCL_{95}	Unit 8	0.07	0.04	0.89	0.08	**1.76**
Zinc	UCL_{95}	RASS 1-3	1.16	7.10	341.62	0.003	0.16
	UCL_{95}	RASS 4	1.10	7.10	341.62	0.003	0.15
	UCL_{95}	Unit 8	1.11	7.10	341.62	0.003	0.16

Notes: **Bold** values indicate HQ is greater than 1.0.

a Doses calculated for RASSs 1 through 3, RASS 4, and Unit 8, as described in Section 6.0 of Appendix G.

b Typical doses were calculated as described in Section 6.0 of Appendix G.

c Low and High TRV were calculated as described in Section 6.0 of Appendix G.

HQ Hazard quotient

PCB Polychlorinated biphenyl

RASS Remedial action subsite

TRV Toxicity reference value

UCL_{95} One-side 95 percent upper confidence limit

TABLE 106

SUMMARY OF HAZARD QUOTIENTS FOR THE RIVER OTTER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

A. ORGANIC CHEMICALS

Chemical	Location[a]	1/2 DL Dose[b] (mg/kg-day)	Full Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ_{full} (Full dose/ Low TRV)
100% Clam Diet[e]						
Total DDTs	Slough	0.0004	0.001	0.68	13.57	0.002
PCBs/Aroclors	Slough	0.001	0.003	0.26	0.93	0.01

B. INORGANIC CHEMICALS

Chemical	Location[a]	UCL_{95} Dose[b] (mg/kg-day)	Low TRV[c] (mg/kg-day)	High TRV[c] (mg/kg-day)	HQ (Dose/ High TRV)	HQ (Dose/ Low TRV)
100% Clam Diet[e]						
Arsenic	Main slough	0.19	0.27	3.74	0.05	0.71
Cadmium	Main slough	0.03	0.04	1.95	0.02	0.78
Copper	Main slough	1.41	1.96	459.25	0.003	0.72
Lead	Main slough	0.07	0.001	172.08	0.0004	**56.36**
Mercury	Main slough	0.01	0.21	3.45	0.004	0.07
Selenium	Main slough	0.05	0.04	0.88	0.06	**1.19**
Zinc	Main slough	5.44	6.99	336.47	0.02	0.78
100% Fish Diet[e]						
Arsenic	Main slough	0.02	0.27	3.74	0.01	0.08
Cadmium	Main slough	0.02	0.04	1.95	0.01	0.43
Copper	Main slough	0.27	1.96	459.25	0.001	0.14
Lead	Main slough	0.01	0.001	172.08	0.00004	**5.65**
Mercury	Main slough	0.001	0.21	3.45	0.0004	0.01
Selenium	Main slough	0.01	0.04	0.88	0.01	0.13
Zinc	Main slough	0.30	6.99	336.47	0.02	0.04

Notes:

a For organic chemicals, data from the Rass 3 pond (Pond) and the southern portion of the main slough were used to calculate doses. For inorganic chemicals, data from the main slough were used to calculate doses.

b Doses calculated as described in Section 6.0 of Appendix G.

c Low and High TRVs were calculated as described in Section 6.0 of Appendix G.

d Diet composition based on literature reviews and available data as described in Section 6.0 of Appendix G.

1/2 DL Dose One-half the detection limit was substituted for nondetects.
DDT Dichlorodiphenyltrichloroethane
Full DL Dose The full detection limit was substituted for nondetects.
HQ Hazard quotient
mg/kg-day Milligrams per kilogram per day
PCB Polychlorinated biphenyl
RASS Remedial action subsite
TRV Toxicity reference value

TABLE 107

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO UPLAND AND WETLAND PLANTS FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Line of Evidence	Threshold Level of Concern	Summary of Results	Notes	Risk Characterization for Individual Lines of Evidence
Bioaccumulation – Pickleweed	No threshold level of concern has been defined; tissue:soil BAFs greater than 1.0 were used as a general guideline.	**Spatial Extent:** Tissue:soil BAFs were calculated for green and brown pickleweed tissue collected from 17 locations on the marsh surface in RASS 1. BAFs were below 1.0 for all metals at each of the 17 locations. A summary of results for BAFs calculated for pickleweed is provided in Table 70. **Magnitude:** Not applicable; no BAFs exceeded the threshold level of concern.	Tissue:soil BAFs provide a general measure of bioaccumulation potential but cannot be used to infer the likelihood of harmful ecological effects.	Metals in soil at the Litigation Area have a low potential for bioaccumulation in pickleweed tissue.
Bioaccumulation and Chemistry – Literature review of effects data	No threshold level of concern has been identified; a qualitative comparison of tissue and soil concentrations to effects levels in the literature was conducted.	Maximum concentrations of metals in pickleweed tissue were generally below effects levels from the literature (summarized in Table 71). Maximum soil and sediment concentrations for most metals exceeded at least some chronic effects levels from the literature.	Literature-derived effects levels for metals show a wide range of threshold concentrations among test endpoints as well as high intra- and interspecific variability. Most studies evaluated were not conducted on wetland plants.	Direct comparison of literature-derived effects levels with maximum soil concentrations at the Litigation Area indicates that some unacceptable risk to individual plants may exist at areas where the highest concentrations of metals are found.
Chemistry – Bulk concentrations of metals in soil and sediment	More than four metals exceed ORNL benchmarks or One metal is 5 times the ORNL benchmark	**Spatial Extent:** Soil and sediment concentrations of metals were compared with ORNL soil benchmarks. Metals were detected in soil in all habitat areas, with some concentrations exceeding the threshold level of concern based on comparison of maximum metal concentrations with the threshold levels defined for plants. Areas that showed the highest overall concentration exceeding ORNL benchmarks across sampling locations were Units 6 (RASS 1) and 12 (RASS 2) on the marsh surface, Unit 13 (RASS 3), and Unit 14 (RASS 4 upland). A summary of soil and sediment concentrations of metals and a comparison with ORNL benchmarks is provided in Table 69. **Magnitude:** Soil or sediment concentrations greater than 10 times the ORNL benchmarks were found for selected metals within each of the following areas: Units 6 and 12 on the marsh surface (arsenic, lead, and zinc), RASS 3 and 4 upland (arsenic, lead, mercury, selenium, and zinc), and the RASS 3 pond (zinc).	ORNL benchmarks are based on the lowest-observed-effects concentration for agricultural plants and may not be appropriate for estimating potential effects at the Litigation Area. On the basis of (1) high pH, (2) high organic matter content, (3) high sulfide content, (4) high iron content, and (5) low potential for leaching of metals based on WET-DI and porewater data, most metals in soil and sediment at the Litigation Area are probably bound and unavailable for uptake by plants.	Maximum concentrations of metals measured in soil and sediment exceed ORNL benchmarks at selected locations across the Litigation Area. Some unacceptable risk may exist for individual plants at locations in Units 6 and 12 on the marsh surface, in the RASS 3 and RASS 4 upland, and in the RASS 3 pond where the highest concentrations of metals are found.
Plant Metrics – Percent cover of pickleweed	No threshold level of concern has been defined; percent cover was evaluated qualitatively along a gradient of increasing metal concentrations.	**Spatial Extent:** Pickleweed percent cover was estimated from 560 small mammal trap locations located along 10 transects and 5 sampling grids and compared with concentrations of metals in soil. No distinct trends between percent cover and concentration of metals in soil were found. A summary of the results from this analysis is provided on Figure 78. **Magnitude:** Not applicable; only a qualitative assessment of the data was possible.	Lack of collocation between plant and soil concentration data was a limiting factor in this analysis and may have introduced artifacts that masked actual trends between percent cover and concentration.	High variability in both pickleweed percent cover and metal concentrations and the lack of collocated data limited the usefulness of this analysis, and the results were not found to be informative for indicating potential effects of metals on pickleweed.

TABLE 107 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO UPLAND AND WETLAND PLANTS FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
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NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Line of Evidence	Threshold Level of Concern	Summary of Results	Notes	Risk Characterization for Individual Lines of Evidence
Summaries and Conclusions for Individual Lines of Evidence	**Plant community surveys conducted during the 5 years of postremediation monitoring show that dense stands of common pickleweed occur across the marsh surface. Common pickleweed is found in all areas of the tidal marsh that provide suitable habitat for this species, including areas in the southeastern portion of RASS 1 where high concentrations of arsenic and zinc are common in soil. Calculation of soil:tissue BAFs for pickleweed show that plants are not accumulating significant levels of metals and that unacceptable risk to this species is not indicated.** **Two of the four special status plant species at the Litigation Area, Mason's lilaeopsis and the delta tule pea, are only found along the northern margin of the marsh surface in RASS 1 where concentrations of metals are low and do not pose an unacceptable risk to wetland plants. Soft bird's beak is found in the northwestern region of RASS 1 at a few locations along the main reach of Lost Slough, and it has actively recolonized the remediated portion of RASS 1 in Unit 8. Soft bird's beak has generally shown an increase in population size during the 5 years of postremediation monitoring and, because most stands are in areas with relatively low concentrations of metals in soil, unacceptable risk is not indicated for this species. Suisun marsh aster has spread along Lost Slough in Unit 11 and the ditches in Unit 7 in areas where arsenic and zinc concentrations are elevated. Stands of Suisun marsh aster also occur in other areas across the marsh surface in RASS 1 where concentrations of metals are below a level of concern. Based on the expansion of marsh aster into areas of the site with high metal concentrations and the existence of stands in areas with relatively low concentrations of metals, unacceptable risk is not indicated for this species.** **Comparison of maximum concentrations of metals in soil and sediment with ORNL benchmarks and effects levels from the literature indicate that some unacceptable risk may exist to individual plants at selected locations in Units 6 and 12 on the marsh surface, in the RASS 3 and 4 upland, and in the RASS 3 pond where the highest concentrations of metals are found.** **The spread of introduced, invasive species throughout the tidal marsh may be the greatest risk factor to populations of wetland plants at the Litigation Area. Variation in growing conditions (rainfall, soil moisture, pH, organic matter content, and other factors) at the site probably plays a large role in explaining the year-to-year variations in population sizes and growth characteristics that have been observed.**			
Overall Conclusions for Characterizing Risk to Populations of Upland and Wetland Plants	**Population-level effects were assessed on the basis of (1) the extent to which different plant species are collocated with areas of the site where elevated concentrations of metals are common in soil, (2) estimates of the potential for bioaccumulation of toxicologically significant concentrations of metals, and (3) comparison of exposure point concentrations of metals in soil and tissue with probable effects levels based on ORNL benchmarks and studies from the literature.** **On the basis of these criteria, it is concluded that population-level effects are not indicated for wetland or upland plant species at the Litigation Area. However, some unacceptable risk to individual plants may exist at selected locations in Units 6 and 12 on the marsh surface, in the RASS 3 and 4 upland, and in the RASS 3 pond where the highest concentrations of metals are found.**			

Notes:

BAF Bioaccumulation factor
ORNL Oak Ridge National Laboratory
RASS Remedial action sub site
WET-DI Waste extraction test – deionized water

TABLE 108

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO FISH AND AQUATIC INVERTEBRATES FROM ORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
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NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Line of Evidence	Threshold Level of Concern	Summary of Results	Notes	Risk Characterization Summary
Chemistry – Concentrations of total DDTs and PCBs and Aroclors in sediment and soil	No threshold level of concern has been defined. Total DDTs concentrations were compared with ER-L and ER-M benchmarks. For both total DDTs and Aroclors, location-specific concentrations were compared with a composite measure of risk for inorganic chemicals based on the mean ER-M_q.	**Spatial Extent:** Concentrations of most DDT congeners and PCB mixtures (Aroclors) were infrequently detected in over 170 samples analyzed. Estimated concentrations of total DDTs and PCBs and Aroclors across the site are generally below levels that would pose a risk to aquatic receptors. Results for the analysis of DDTs and PCBs and Aroclors are presented in Tables 58 through 62 and on Figures 79 and 80. **Magnitude:** At least one DDT congener was detected at 30 locations, and concentrations of total DDTs based on detected data ranged from 1.9 to 329 µg/kg. Total DDTs exceeded the ER-M for sediment (46.1 µg/kg) at only one location in the RASS 4 wetland (R04WD212). At least one PCB congener or Aroclor was detected at 14 locations, and the ranges for total PCBs and total Aroclors were 0.24 to 2.05 µg/kg and 45 to 1,500 µg/kg. All concentrations of total detected PCBs were below the ER-L benchmark of 22.7 µg/kg. No sediment benchmark exists for total Aroclors. Total concentrations of Aroclors based on detected data only exceeded the ER-M benchmark for total PCBs (180 µg/kg) at four locations.	The risk assessment for DDT and PCBs and Aroclors was based on a reanalysis of data from the QEA (PRC 1997c); the reanalysis was prompted by regulatory agency concerns that risk from DDT and PCBs was not adequately characterized because of the high detection limits and low frequency of detection reported for these organic compounds in the QEA. The reanalysis estimated total concentrations of DDTs and PCBs and Aroclors by substituting both one-half and the full detection limit for all nondetected congeners in calculations. Locations with high potential concentrations of total DDTs or Aroclors (based on estimates of worst-case concentrations) but low risk from metals were plotted on a map to identify areas that might be overlooked if risk characterization is based on metals alone.	DDT in sediment and soil at the Litigation Area does not pose unacceptable risk to fish and aquatic invertebrates. Both detected and estimated concentrations of DDT at the site are generally low and are below levels that would warrant remedial action. Concentrations detected in sediment and soil reflect low levels of residual contamination from DDT that was legally applied for mosquito abatement before 1972. PCBs and Aroclors were infrequently detected, and estimated concentrations are generally below levels that pose unacceptable risk to fish and aquatic invertebrates.
Overall Conclusions for Characterizing Risk to Populations of Fish and Aquatic Invertebrates	**Population-level effects were assessed based on the detection frequencies and measured or estimated concentrations of DDTs and PCBs and Aroclors, as well as the frequency and magnitude of concentrations exceeding threshold criteria at locations within each spatial unit.** **Population-level effects to fish and aquatic invertebrates are not indicated based on the low frequencies with which DDTs and PCBs and Aroclors have been detected across the site, as well as the generally low concentrations measured or estimated for these chemicals.**			

Notes:

DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ER-M_q Effects range-median quotient
µg/kg Microgram per kilogram
PCB Polychlorinated biphenyl
PRC PRC Environmental Management, Inc.
QEA Qualitative ecological assessment

Source:

PRC. 1997c. "Qualitative Ecological Assessment, Litigation Area, Naval Weapons Station, Concord, California." September 2.

TABLE 109

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO FISH AND AQUATIC INVERTEBRATES FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
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NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Line of Evidence[a]	Threshold Level of Concern	Summary of Results	Notes	Risk characterization for Individual Lines of Evidence
Toxicity – Percent hatch in topsmelt 12-day sediment-water interface bioassays	Mean percent hatch less than 80 percent of mean percent hatch in laboratory controls.	**Spatial Extent:** Percent hatch at three locations in Unit 9, four locations in Unit 10, one location in Unit 11 in Lost Slough, and two locations in the RASS 3 pond were below the threshold level of concern. Test results are summarized in Table 78 and on Figure 85. **Magnitude:** Not applicable; results at all slough and pond locations evaluated were below the threshold level of concern	Locations evaluated using the topsmelt bioassay did not reflect the highest sediment concentrations of metals that have been measured at the Litigation Area.	Results of the topsmelt 12-day sediment-water interface bioassay do not indicate unacceptable risk to fish in Units 9, 10, and 11 in Lost Slough and in the RASS 3 pond (Unit 13).
Toxicity – Percent survival in *Eohaustorius estuarius* 10-day bulk-sediment bioassays	Mean percent survival less than RWQCB reference envelope edge of 68 percent.	**Spatial Extent:** Percent survival was below 68 percent at 1 out of 5 locations evaluated in Unit 11 in Lost Slough (R01SH305) and at 1 out of 10 locations evaluated in Unit 1 on the marsh surface (MHRSS005). Survival reported at six locations in the Unit 7 ditches, seven locations in Lost Slough (Units 9, 10, and 11), two locations in the RASS 3 pond (Unit 13), and nine locations on the marsh surface (Units 1, 2, 4, and 6) did not show unacceptable risk to aquatic invertebrates. Test results are summarized in Tables 80 and 81 and on Figure 85. **Magnitude:** Survival at both locations where toxicity was indicated, R01SH305 (62 percent) and MHRSS005 (67 percent), was only marginally lower than the threshold level of concern of 68 percent.	Percent survival was poorly correlated with bulk sediment chemistry and other physical and chemical parameters (Tables 82 and 83). Limited bioavailability of metals is a likely explanation for the lack of association between toxicity and sediment chemistry (see "Chemistry – concentrations of metals in sediment and soil" below). The lack of association between survivorship and sediment chemistry suggests that bulk sediment chemistry alone cannot be used to predict the likelihood of adverse effects.	Some unacceptable risk to aquatic invertebrates in Unit 11 was indicated based on the results of *Eohaustorius* bulk sediment bioassays; unacceptable risk was found at one out of five locations evaluated, but was only marginally below the 68 percent threshold level of concern.
Toxicity – Percent survival and growth in *Hyalella azteca* 14-day bulk-sediment bioassays	Mean percent survival and growth less than 80 percent of mean percent survival, and growth in laboratory controls (laboratory control was 82.5 percent; threshold level of concern is 66 percent).	**Spatial Extent:** Percent survival was below 80 percent of the laboratory control at one out of three locations evaluated in Unit 10 (R01SH131) and at one out of four locations evaluated in Unit 11 (R01SH307) in Lost Slough. Survival reported at three locations in the Unit 7 ditches and at three locations in Unit 9 in Lost Slough did not show unacceptable risk to aquatic invertebrates. No results for the growth endpoint exceeded the threshold level of concern. Test results are summarized in Table 84 and on Figure 85. **Magnitude:** Survival at two slough locations, R01SH131 (57.5 percent) and R01SH307 (47.5 percent), was below the threshold level of concern of 66 percent by a margin of 13 to 28 percent.	Percent survival and growth were poorly correlated with bulk sediment chemistry and other physical and chemical parameters (Table 85). Limited bioavailability of metals is a likely explanation for the lack of association between toxicity and sediment chemistry (see "Chemistry – concentrations of metals in sediment and soil" below). The lack of association between survivorship and sediment chemistry suggests that bulk sediment chemistry alone cannot be used to predict the likelihood of adverse effects.	Some unacceptable risk to aquatic invertebrates in Units 10 and 11 in Lost Slough was indicated based on the results of *Hyalella* bulk sediment bioassays; unacceptable risk was found at one out three locations in Unit 10 and one out of four locations in Unit 11.
Bioaccumulation – Asiatic clam tissue	No threshold level of concern has been defined; tissue:sediment BAFs greater than 1.0 were used as a general guideline.	**Spatial Extent:** Tissue:sediment BAFs for clam tissue exceeded 1.0 for four metals in Unit 9 in Lost Slough (number of locations out of three locations sampled is shown in parentheses): arsenic (1), copper (3), mercury (3), and zinc (2). BAFs exceeded 1.0 for mercury at one out of four locations evaluated in Unit 10 in Lost Slough and for both copper and selenium at one out three locations evaluated in Unit 11 in Lost Slough. BAFs for clam tissue are summarized in Tables 74 and 75, and locations with BAFs greater than 1.0 are shown on Figure 93. **Magnitude:** Maximum tissue:sediment BAFs measured for each metal included arsenic (1.14), copper (1.64), mercury (14.2), selenium (1.65), and zinc (1.25). Maximum BAFs for arsenic, copper, and zinc were found in Unit 9 near the mouth of Lost Slough. Maximum BAFs for mercury and selenium were found in Units 10 and 11 in Lost Slough.	Calculation of tissue:sediment BAFs can only be used to estimate the potential for bioaccumulation of metals and does not infer the likelihood of harmful ecological effects to aquatic invertebrates. Risk to higher trophic-level receptors was evaluated using food-chain modeling.	Some unacceptable bioaccumulation was indicated for arsenic, copper, mercury, and zinc in Unit 9 near the mouth of Lost Slough; for mercury in Unit 10 in Lost Slough; and for copper and selenium in Unit 11 in Lost Slough. The magnitude of concentrations exceeding the threshold level of concern was high only for mercury in one sample from Unit 10 in Lost Slough.

TABLE 109 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO FISH AND AQUATIC INVERTEBRATES FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
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NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Line of Evidence[a]	Threshold Level of Concern	Summary of Results	Notes	Risk characterization for Individual Lines of Evidence
Bioaccumulation – Tissue from other taxa (sculpin, stickleback, crayfish, amphipod, damselfly nymph)	No threshold level of concern has been defined; tissue:sediment BAFs greater than 1.0 were used as general guideline.	**Spatial Extent:** Tissue:sediment BAFs were calculated for the following tissues (number of samples in parentheses): sculpin (3), stickleback (2), tadpole (1), crayfish (1), amphipod (3), and damselfly nymph (1). BAFs exceeded 1.0 for the following tissues and metals (number of samples with BAFs greater than 1.0 in parentheses): mercury (2) and selenium (1) in the stickleback and copper (1) in the crayfish. All samples with BAFs greater than 1.0 were collected in the RASS 3 pond. BAF results are summarized in Table 76. **Magnitude:** The maximum BAFs for the stickleback were 4.3 (mercury) and 4.8 (selenium); the BAF for copper in the crayfish was 2.7.	Only limited data are available for estimating bioaccumulation potential, therefore, BAF results may not be representative of the site. Risk to higher trophic-level receptors was evaluated using food-chain modeling.	Some unacceptable bioaccumulation was indicated for Hg and Se in the stickleback and for Cu in crayfish in the RASS 3 pond; BAFs for each of these tissues and metals were less than 5.0.
Chemistry – SEM-AVS	No threshold level of concern has been defined; SEM-AVS greater than 0 was used as general guideline that metals are potentially available.	**Spatial Extent:** SEM-AVS was calculated for three locations in the Unit 7 ditches, and for three locations in Unit 9, three locations in Unit 10, and four locations in Unit 11 in Lost Slough. SEM-AVS was greater than 0 at only one ditch location in Unit 7 (R01DH302). A summary of SEM-AVS results is presented in Table 86. **Magnitude:** The SEM-AVS difference at ditch location R01DH302 was 14. Three locations in the slough reference area (Unit 9) had SEM-AVS differences close to 0: SLRSH01 (-1), SLRSH02 (-2), and SLRSH03 (-1).	SEM-AVS is only suitable for evaluating anoxic sediment; changes in redox conditions can alter the binding capacity of sediment. Metals shown to be unbound by SEM-AVS are potentially available, but actual bioavailability is unknown.	SEM-AVS results suggest that excess sulfide is present in anoxic sediment in the Litigation Area, and most metals are bound and unavailable.
Chemistry – Concentrations of metals in sediment extractions (WET)	No threshold level of concern has been defined; the fraction of total metals in bulk sediment and soil recovered in WET-DI extracts was used as a qualitative measure of potential availability of metals.	**Spatial Extent:** Concentrations of metals in WET-DI extractions were compared with bulk sediment and soil concentrations for 34 samples collected from the marsh surface (Units 1, 2, 4, and 6), ditches (Units 3 and 5), Lost Slough (Units 9, 10, and 11), RASS 3 pond (Unit 13), and RASS 3 upland (Unit 12). The fraction of each metal recovered in the extract was determined and used as a general indicator of potential availability. A summary of results is provided in Table 72. **Magnitude:** The maximum fraction of metals in bulk sediment and soil recovered in WET-DI extracts was less than 6 percent for all metals (range of 0.03 percent for copper to 5.1 percent for zinc).	Metal concentrations in WET-DI extracts can only be used as a general indicator of leaching potential and availability. The fraction of metals that are actually bioavailable is unknown.	Results of WET-DI tests indicate that less than 6 percent of arsenic, cadmium, copper, lead, and zinc in sediment and soil are soluble and potentially available to aquatic organisms.
Chemistry – Concentrations of metals in sediment pore water	No threshold level of concern has been defined; the fraction of total metals in bulk sediment recovered in pore water was used as a qualitative measure of potential availability of metals.	**Spatial Extent:** Concentrations of metals in sediment pore water were compared with bulk sediment concentrations for 10 samples collected from Lost Slough (Units 9, 10, and 11) and the RASS 3 pond (Unit 13). The fraction of each metal recovered in pore water was determined and used as a general indicator of potential availability. A summary of results is provided in Table 73. **Magnitude:** The maximum fraction of metals in bulk sediment measured in pore water was less than 0.5 percent for all metals.	Metal concentrations in pore water can only be used as a general indicator of availability. The fraction of metals that are actually bioavailable is unknown.	Porewater results indicate that less than 0.5 percent of metals in bulk sediment is soluble and potentially available to aquatic organisms in the porewater phase.

TABLE 109 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO FISH AND AQUATIC INVERTEBRATES FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
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Line of Evidence[a]	Threshold Level of Concern	Summary of Results	Notes	Risk characterization for Individual Lines of Evidence
Chemistry – Concentrations of metals in sediment and soil	Mean ER-M_q greater than 0.50 or Three metals greater than ER-M or One metal greater than 5 times ER-M	**Spatial Extent:** Widespread concentrations exceeding the threshold level of concern were found across the site. All habitats and spatial units sampled had a large number of locations where maximum metal concentrations exceeded at least one of the threshold criterion. Summaries of metal concentrations in sediment and soil are provided in Tables 55 and 77; on Figures 22 through 33, 83, and 84; and in Attachments G1 and G3. **Magnitude:** A hotspot analysis was conducted to identify the most contaminated portions of the site based on the following definitions for hotspot concentrations (data summaries in Tables 63 through 66): (1) locations where maximum concentrations of any one metal were identified as statistical outliers[b], and (2) locations where the maximum mean ER-M_q were identified as statistical outliers[b]. Areas identified that showed the highest and most consistent elevation of metal concentrations across locations included (primary metals of concern in parentheses): Unit 6 on the marsh surface (arsenic, copper, lead, and zinc), Unit 7 ditches (arsenic, cadmium, copper, and zinc), Unit 11 in Lost Slough (arsenic, cadmium, selenium, and zinc), Unit 10 in Lost Slough (arsenic, cadmium, and zinc), and Unit 13, including Nichols Creek downstream from the Chemical Pigment Company property (lead and zinc) and the RASS 3 pond (cadmium and zinc).	On the basis of (1) high pH, (2) high organic matter content, (3) high sulfide content, (4) low SEM-AVS, and (5) high iron content, most metals in sediment and soil are probably bound and unavailable for uptake by aquatic organisms. Potential mobility of metals in the ditches, the slough, and along Nichols Creek may be a factor that could increase the availability of metals. Elevated concentrations of metals on the marsh surface are predominantly in deeper soils (below 3 to 5 inches) and are relatively immobile; therefore, exposure potential for some ecological receptors is low.	Bulk chemistry results for sediment and soil show widespread concentrations exceeding effects thresholds for metals based on the ER-M and ER-M_q. If mobility and transport increase the potential for bioavailability of metals, then some unacceptable risk to aquatic receptors may be present in the following areas (metals of potential concern in parentheses): Unit 7 ditches (arsenic, cadmium, copper, and zinc), Unit 11 in Lost Slough (arsenic, cadmium, selenium, and zinc), Unit 10 in Lost Slough (arsenic, cadmium, and zinc), and Nichols Creek downstream from the Chemical Pigment Company property (lead and zinc) and the RASS 3 pond (cadmium and zinc).
Chemistry – Concentrations of metals in surface water	One metal greater than acute AWQC or Two metals greater than chronic AWQC or One metal greater than 2 times chronic AWQC	**Spatial Extent:** Widespread concentrations exceeding the threshold level of concern for total metals were found for arsenic, copper, and zinc in the ditches (Units 3, 5, and 7), Lost Slough (Units 9, 10, and 11), and Nichols Creek (Unit 13 – copper and zinc only). Widespread concentrations exceeding the threshold level of concern for dissolved metals were found for copper in the ditches (Unit 7) and Lost Slough (Units 9, 10, and 11). Summaries of metal concentrations in surface water are provided in Tables 57, 67, and 68; on Figures 38 through 43, 86, and 87; and in Attachment G2. **Magnitude:** Maximum concentrations of total arsenic, copper, and zinc in the Unit 7 ditches exceeded acute AWQC by factors of 43; 1,248; and 327 times. Maximum concentrations of total arsenic, copper, and zinc in Lost Slough exceeded acute AWQC by factors of 7.5, 174, and 422 times. Maximum concentrations of total copper and zinc in Nichols Creek exceeded acute AWQC by factors of 110 and 1,104 times. Maximum concentrations of dissolved copper exceeded the acute AWQC by a factor of 7.5 times in Lost Slough (Units 9, 10, and 11) and by a factor of 29 times in the Unit 7 ditches.	Concentrations of total and dissolved copper have not been well characterized because of the high detection limits for copper analyzed under the CLP protocols and the low frequency of detection. Concentrations exceeding water quality criteria for total metals may not be an accurate reflection of risk as surface water chemistry results for total metals do not indicate the fraction of metals that are bioavailable.	Some unacceptable risk to aquatic receptors may be indicated on the basis of concentrations exceeding dissolved water quality criteria for copper in the Unit 7 ditches, Units 9, 10, and 11 in Lost Slough, and in Nichols Creek (Unit 13).

TABLE 109 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO FISH AND AQUATIC INVERTEBRATES FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
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CONCORD, CALIFORNIA

Line of Evidence[a]	Threshold Level of Concern	Summary of Results	Notes	Risk characterization for Individual Lines of Evidence
Summaries and Conclusions for Individual Lines of Evidence	**Direct Measures of Toxicity: Toxicity tests using amphipods showed unacceptable risk to aquatic invertebrates at one out of four locations in Unit 10 and at two out of four locations in Unit 11 in Lost Slough; however, at most of these locations the magnitude of concentrations exceeding the threshold levels of concern defined for each bioassay was low. Amphipod toxicity test results showed no unacceptable risk to aquatic invertebrates at six locations in the Unit 7 ditches, at three locations in Unit 9 in Lost Slough, at two locations in the RASS 3 pond, at one location in the RASS 4 wetland, and at nine locations on the marsh surface (Units 1, 2, 4, and 6). Results from topsmelt sediment-water interface bioassays showed no unacceptable risk to fish at any location tested (three locations in Unit 9, four locations in Unit 10, and one location in Unit 11 and two locations in the RASS 3 pond in Lost Slough).** **Bioaccumulation: Some unacceptable bioaccumulation in clam tissue was reported for arsenic, copper, mercury, and zinc in Unit 9; for mercury in Unit 10; and for copper and selenium in Unit 11 in Lost Slough; however, most BAFs were only slightly greater than 1.0. Only mercury in one sample from Unit 10 had a BAF that exceeded the threshold level of concern by a wide margin (BAF = 14.3). Some unacceptable bioaccumulation was found for mercury and selenium in stickleback tissue and for copper in crayfish tissue from the RASS 3 pond; for both the stickleback and crayfish, all BAFs were less than 5.0.** **Chemistry (soil and sediment): Bulk sediment chemistry results show widespread concentrations exceeding sediment benchmarks based on the ER-M and ER-M_q from most spatial units in all habitats. Concentrations of metals in sediment are highest in Units 10 and 11 in Lost Slough and in Units 6 and 7 in the southeastern portion of RASS 1. Concentrations of metals in sediment, however, are poorly correlated with measured effects in bioassays, and bulk chemistry alone cannot be used to predict the level of unacceptable risk at site locations. Mobility and transport of contaminated sediment may increase the bioavailability potential of metals and, therefore, should be considered a risk factor in the ditches (Unit 7), Lost Slough (Units 10 and 11), and along Nichols Creek downstream from the Chemical Pigment Company property (Unit 13).** **Chemistry (surface water): Surface water chemistry results show total concentrations of arsenic, copper, and zinc exceeding AWQC in the ditches (Units 3, 5, 7), Lost Slough (Units 9, 10, and 11), and Nichols Creek (copper and zinc only); however, elevated concentrations of total metals in surface water above AWQC overestimate the bioavailable fraction of metals. Elevated concentrations of dissolved copper above AWQC were found in the ditches (Unit 7), Lost Slough (Units 9, 10 and 11), and Nichols Creek, and copper may pose some unacceptable risk to aquatic receptors in these areas.**			
Overall Conclusions for Characterizing Risk to Populations of Fish and Aquatic Invertebrates	**Population-level effects were assessed on the basis of (1) the frequency and magnitude of concentrations exceeding threshold criteria at individual locations, and (2) the proportion of locations within each spatial unit where threshold criteria were exceeded.** **Based on the cooccurrence of toxicity in amphipod bioassays, unacceptable bioaccumulation potential, and elevated concentrations of metals in sediment and surface water at some locations, portions of the western arm (Unit 11) and main reach (Unit 10) of Lost Slough may pose some unacceptable risk to populations of aquatic receptors. The magnitude of effects observed in toxicity tests was small; however, the spatial extent of chemical exceedances and the multiple lines of evidence suggesting unacceptable risk in Units 10 and 11 indicate potential population-level effects to fish and aquatic invertebrates.** **While some elevated concentrations are found in Units 3, 5, 7, and 9 and the RASS 3 pond (Unit 13), unacceptable population-level effects are not indicated in these areas. Unit 7 (ditches) and the RASS 3 pond may act as on-site sources of contaminants to Lost Slough.**			

Notes:

a Lines of evidence are presented in order of importance for characterizing risk, with direct measures of toxicity and bioaccumulation considered as stronger lines of evidence than bulk chemistry results.
b A concentration equal to the 75th percentile of the sitewide distribution of concentrations (or mean ER-Mq values) plus the IQR.

AWQC Ambient water quality criteria
BAF Bioaccumulation factor
ER-L Effects range-low
ER-M Effects range-median
ER-M_q Effects range-median quotient
IQR Interquartile range (equal to the difference between the 75th and 25th percentile of a defined distribution)
RWQCB California Regional Water Quality Control Board
SEM-AVS Simultaneously extracted metals and acid volatile sulfide
WET-DI Waste extraction test-deionized water

TABLE 110

COMPARISON OF SURFACE WATER CHEMISTRY RESULTS FOR COLLOCATED SLOUGH SAMPLES
COLLECTED BY THE U.S. DEPARTMENT OF THE NAVY AND CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD IN OCTOBER 2000
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Location	Source of Data	Total and Dissolved Metal Concentrations (µg/L)											
		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
R01SH092	Navy	< 7.7	< 5.8	< 0.20	< 0.20	< 5.8	< 1.3	< 1.1	< 1.1	< 3.3	< 3.3	75.0 J	29.1 J
	RWQCB	NA	NA	0.377	0.020	5.59	0.89	1.436	< 0.056	NA	NA	NA	NA
R01SH118	Navy	< 3.2	< 3.5	< 0.20	< 0.20	< 2.8	27.8	< 1.1	< 1.1	< 3.3	< 3.3	32.0 J	28.5 J
	RWQCB	1.38	0.85	0.37	0.14	3.21	1.44	0.80	< 0.056	0.15	0.12	34.71	28.48
	RWQCB (Duplicate)	1.21	0.64	0.36	0.12	3.21	1.38	0.78	0.08	0.16	0.14	30.49	29.87
R01SH133	Navy	< 5.3	< 4.3	< 0.40	< 0.20	< 5.8	25.4	< 1.1	< 1.1	< 3.3	< 3.3	33.3 J	27.8 J
	RWQCB	NA	NA	0.286	0.061	2.19	1.01	0.698	< 0.056	NA	NA	NA	NA
R01SH265	Navy	16.4	< 8.2	< 0.20	< 0.50	< 10.3	< 10.5	< 1.1	< 1.1	< 3.3	< 3.3	81.4 J	52.1 J
	RWQCB	NA	NA	6.99	0.119	144.0	2.16	17.18	< 0.056	NA	NA	NA	NA

Notes: All samples were collected on October 9, 2000.
Samples collected by the Navy were analyzed using regular CLP methods.
Samples were collected by the RWQCB using ultraclean techniques and were analyzed using low-level methods.

< Concentration is less than the reporting limit shown in the table
CLP Contract Laboratory Program
µg/L Micrograms per liter
NA Not analyzed
Navy U.S. Department of the Navy
RWQCB California Regional Water Quality Control Board

TABLE 111

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO BIRDS AND MAMMALS FROM ORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor	Threshold of Concern	Summary of Results	Notes	Risk Characterization for Receptor
California Black Rail (*Laterallus jamaicensis coturniculus)*	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** All HQs calculated for total DDTs using the high TRV were below 1.0. HQs for total PCBs and total Aroclors (PCBs/Aroclors) were less than 1.0 for dose calculations based on site-specific clam tissue data; however, HQs calculated for PCBs/Aroclors were greater than 1.0 in the ditches (Units 5 and 7) for dose calculations based on amphipod tissue and estimated concentrations of PCBs from literature-derived BAFs. Summaries of the exposure parameters used in the dose model and HQs for the California Black Rail are provided in Tables 89 and 98. **Magnitude:** The total PCBs/Aroclors HQ based on the full DL dose was 2.4 based on a diet of amphipods (estimated tissue concentration) and 0.2 based on a diet of clams (site-specific tissue concentration). The HQ based on the 1/2-DL dose was 1.2 based on a diet of amphipods (estimated tissue concentration) and 0.08 based on a diet of clams (site-specific tissue concentration). All other HQs were below 1.0.	Amphipod diet doses exceeded 1.0 because concentrations in prey tissue were estimated using literature-derived BAFs and maximum sediment concentrations (BAF × maximum sediment = tissue). Uncertainty is associated with the use of nonsite-specific tissue estimations, and the doses based on site-specific clam data are considered more reliable.	Risk to the California Black Rail from organic COPECs was below the threshold level of concern when site-specific tissues (clams) were used in the dose model. Some risk to the California Black Rail from total PCBs/Aroclors was indicated in the ditches when literature-derived amphipod tissues were used in the dose model; however, the HQ calculated using estimated concentrations of PCBs in amphipod tissue did not exceed 1.0 by a wide margin.
Mallard (*Anas platyrhynchos*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs calculated using the high TRV were greater than 1.0 for total DDTs or total PCBs/Aroclors for the Mallard. Summaries of the exposure parameters used in the dose model and HQs for the Mallard are provided in Tables 91 and 100. **Magnitude:** NA	Mallard doses incorporated both site-specific and literature-derived tissue concentrations; more uncertainty is associated with literature-derived tissue concentrations.	Risk to the Mallard from organic COPECs was below the threshold level of concern.
Great Blue Heron (*Ardea herodias*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs calculated using the high TRV were greater than 1.0 for total DDTs or total PCBs/Aroclors for the Great Blue Heron. Summaries of the exposure parameters used in the dose model and HQs for the Great Blue Heron are provided in Tables 92 and 101. **Magnitude:** NA	Great Blue Heron doses incorporated both site-specific and literature-derived tissue concentrations; more uncertainty is associated with literature-derived tissue concentrations.	Risk to the Great Blue Heron from organic COPECs was below the threshold level of concern.
Northern Harrier (*Circus cyaneus*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs calculated using the high TRV were greater than 1.0 for total DDTs or total PCBs/Aroclors for the Northern Harrier. Summaries of the exposure parameters used in the dose model and HQs for the Northern Harrier are provided in Tables 94 and 103. **Magnitude:** NA	Northern Harrier doses were based on literature-derived tissue concentrations; more uncertainty is associated with literature-derived tissue concentrations.	Risk to the Northern Harrier from organic COPECs was below the threshold level of concern.
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs calculated using the high TRV were greater than 1.0 for total DDTs or total PCBs/Aroclors for the salt marsh harvest mouse. Summaries of the exposure parameters used in the dose model and HQs for the salt marsh harvest mouse are provided in Tables 95 and 104. **Magnitude:** NA	Salt marsh harvest mouse doses were based on literature-derived tissue concentrations; more uncertainty is associated with literature-derived tissue concentrations.	Risk to the salt marsh harvest mouse from organic COPECs was below the threshold level of concern.
River Otter (*Lutra Canadensis*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs using the high TRV were greater than 1.0 for total DDTs or total PCBs/Aroclors for the river otter. Summaries of the exposure parameters used in the dose model and HQs for the river otter are provided in Tables 97 and 106. **Magnitude:** NA	River otter doses were based on site-specific tissue concentrations.	Risk to the river otter from organic COPECs was below the threshold level of concern.

TABLE 111 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO BIRDS AND MAMMALS FROM ORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor	Threshold of Concern	Summary of Results	Notes	Risk Characterization for Receptor
Summaries and Conclusions for Individual Receptors	**Risk to the Mallard, Great Blue Heron, American Kestrel, Northern Harrier, salt marsh harvest mouse, and river otter from DDTs and PCBs was below the threshold level of concern.** **Risk to the California Black Rail from DDTs was below the threshold level of concern. Risk to the California Black Rail from PCBs was below the threshold level of concern when the ingested dose was calculated using site-specific clam tissue; however, an HQ of 2.4 was calculated for the California Black Rail using the full DL dose and a diet of 100 percent amphipods, where concentrations of PCBs in prey tissue were estimated using literature-derived BAFs.**			
Overall Conclusions for Characterizing Risk to Populations of Birds and Mammals	**Population-level effects were assessed by (1) estimating the fraction of each receptors' habitat where risk was determined to be unacceptable based on calculation of an HQ (dose/TRV_{high}) greater than 1.0, (2) consideration of the magnitude by which calculated doses exceeded the TRV_{high}, and (3) consideration of the specific factors (that is, elevated concentrations of organic contaminants in prey tissue and soil or sediment) responsible for HQs that exceed 1.0. For special status species, effects to individuals were also assessed.** **Population-level effects from exposure to DDTs and PCBs are not indicated for any bird or mammal species at the Litigation Area. All estimates of the ingested chemical dose for the Mallard, Great Blue Heron, American Kestrel, Northern Harrier, salt marsh harvest mouse, and river otter were less than the TRV_{high} for DDTs and PCBs. Population-level effects are also not indicated for the California Black Rail from exposure to DDTs (ingested dose < TRV_{high}). Concentrations exceeding the TRV_{high} for PCBs was shown for the California Black Rail when the ingested dose was calculated using estimated concentrations of PCBs in amphipod tissue, however, population-level effects are not indicated for this species because (1) unacceptable risk is only indicated for a small number of locations within the range of this species at the Litigation Area, (2) the HQ calculated using estimated concentrations of PCBs in prey tissue did not exceed 1.0 by a significant margin, and (3) unacceptable risk is not indicated when the ingested dose is calculated using site-specific tissue for clams.**			

Notes: A summary of the approach used to estimate risk to birds and mammals from inorganic chemicals is provided in Table 88.

1/2 DL	Total summed using one half the detection limit as a substitute for nondetects
BAF	Bioaccumulation factor
COPEC	Chemical of potential ecological concern
DDT	Dichlorodiphenyltrichloroethane
DL	Detection limit
Full DL	Total summed using the full detection limit as a substitute for nondetects
HQ	Hazard quotient (dose/TRV)
NA	Not applicable
PCB	Polychlorinated biphenyl
TRV_{high}	High toxicity reference value

TABLE 112

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO BIRDS AND MAMMALS FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor	Threshold of Concern	Summary of Results	Notes	Risk Characterization for Receptor
California Black Rail (*Laterallus jamaicensis coturniculus)*	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** HQs calculated using the high TRV were greater than 1.0 for arsenic, cadmium, copper, lead, and zinc in Lost Slough. Locations in Lost Slough and the ditches in Unit 5 and 7 where sediment concentrations would result in HQs greater than 1.0 on the basis of back calculations from the dose model are listed in Section 7.4.3.1 and shown on Figure 94. Summaries of the exposure parameters used in the dose model and HQs for the California Black Rail are provided in Tables 89 and 98. **Magnitude:** The highest HQs were recorded for copper (1.7) and zinc (12.7) in the main slough. All other HQs were below 1.5.	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and sediment bioavailability.	Some unacceptable risk from arsenic, cadmium, copper, lead, and zinc is indicated for California Black Rails utilizing areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7. Zinc is the primary risk driver for the California Black Rail.
Suisun Song Sparrow (*Melospiza melodia maxillaris*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** HQs calculated using the high TRV were greater than 1.0 for copper and zinc in Lost Slough based on a diet of amphipods. HQs calculated using the high TRV were greater than 1.0 for selenium based on a diet of plants and amphipods. Locations in Lost Slough and the ditches in Unit 5 and 7 where sediment concentrations would result in HQs greater than 1.0 on the basis of back calculations from the dose model are the same that would pose a risk to the Black Rail, as indicated on Figure 94. Summaries of the exposure parameters used in the dose model and HQs for the Song Sparrow are provided in Tables 90 and 99. **Magnitude:** The highest HQ was recorded for selenium (3.6) based on a diet of plants and amphipods; the HQ for selenium was less than 1.0 based on a diet of amphipods. All other HQs were below 1.5.	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and sediment bioavailability.	Some unacceptable risk from copper, selenium, and zinc is indicated for Song Sparrows utilizing areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7. Selenium is the primary risk driver for the Song Sparrow.
Mallard (*Anas platyrhynchos*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs greater than 1.0 using the high TRV were calculated for the Mallard. Summaries of the exposure parameters used in the dose model and HQs for the Mallard are provided in Tables 91 and 100. **Magnitude:** NA	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and sediment bioavailability.	Risk to the Mallard from all inorganic COPECs was below the threshold level of concern.
Great Blue Heron (*Ardea herodias*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs greater than 1.0 using the high TRV were calculated for the Great Blue Heron. Summaries of the exposure parameters used in the dose model and HQs for the Great Blue Heron are provided in Tables 92 and 101. **Magnitude:** NA	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and sediment bioavailability.	Risk to the Great Blue Heron from all inorganic COPECs was below the threshold level of concern.
American Kestrel (*Falco sparverius*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs greater than 1.0 using the high TRV were calculated for the American Kestrel. Summaries of the exposure parameters used in the dose model and HQs for the American Kestrel are provided in Tables 93 and 102. **Magnitude:** NA	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and soil bioavailability.	Risk to the American Kestrel from all inorganic COPECs was below the threshold level of concern.
Northern Harrier (*Circus cyaneus*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs greater than 1.0 using the high TRV were calculated for the Northern Harrier. Summaries of the exposure parameters used in the dose model and HQs for the Northern Harrier are provided in Tables 94 and 103. **Magnitude:** NA	The dose is likely an overestimation of true risk because of an assumption of 100 pecent prey and soil bioavailability.	Risk to the Northern Harrier from all inorganic COPECs was below the threshold level of concern.

TABLE 112 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO BIRDS AND MAMMALS FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor	Threshold of Concern	Summary of Results	Notes	Risk Characterization for Receptor
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** Only five locations in Unit 6 had HQs for arsenic that were slightly greater than 1.0 on the basis of back calculations and comparisons with the high TRV. Locations in Unit 6 where sediment concentrations would result in HQs greater than 1.0 on the basis of back calculations from the dose model are listed in Section 7.4.4.1 and shown on Figure 94. Summaries of the exposure parameters used in the dose model and HQs for the salt marsh harvest mouse are provided in Tables 95 and 104. **Magnitude:** The areawide HQ calculated for arsenic using the high TRV in Unit 6 was only slightly above 1.0. (1.12).	The dose is likely an overestimation of true risk because of the following reasons: • An assumption of 100 percent prey and sediment bioavailability. • Salt marsh harvest mice are mainly exposed to soil and sediments at the top of the marsh surface. A vertical profile of sediment data on the marsh surface (Figure 52) shows that the maximum concentrations of arsenic are at depths greater than 3 to 4 inches bgs, which the mouse is less likely to encounter than cleaner sediment at depths of 1 to 2 inches bgs.	Some unacceptable risk from arsenic was indicated for the salt marsh harvest mouse at five locations in Unit 6; however, the HQ calculated comparing the maximum dose with the TRV_{high} was only slightly greater than 1.0
Gray Fox (*Urocyon cinereoargenteus*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs greater than 1.0 using the high TRV were calculated for the gray fox. Summaries of the exposure parameters used in the dose model and HQs for the gray fox are provided in Tables 96 and 105. **Magnitude:** NA	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and soil bioavailability.	Risk to the gray fox from all inorganic COPECs was below the threshold level of concern.
River Otter (*Lutra canadensis*)	Dose/TRV_{high} greater than 1.0	**Spatial Extent:** No HQs greater than 1.0 using the high TRV were calculated for the River Otter. Summaries of the exposure parameters used in the dose model and HQs for the river otter are provided in Tables 97 and 106. **Magnitude:** NA	The dose is likely an overestimation of true risk because of an assumption of 100 percent prey and soil bioavailability.	Risk to the river otter from all inorganic COPECs was below the threshold level of concern.
Summaries and Conclusions for Individual Receptors	**Risk to the Mallard, Great Blue Heron, American Kestrel, Northern Harrier, gray fox, and river otter was below the threshold level of concern for all inorganic COPECs.** **Some unacceptable risk from arsenic, cadmium, copper, lead, and zinc was indicated for California Black Rails utilizing areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7. Zinc is the primary risk driver for the California Black Rail.** **Some unacceptable risk from copper, selenium, and zinc was indicated for Suisun Song Sparrows utilizing areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7. Selenium is the primary risk driver for the Song Sparrow.** **Some unacceptable risk from arsenic was indicated for the salt marsh harvest mouse at five locations in Unit 6.**			

TABLE 112 (Continued)

WEIGHT-OF-EVIDENCE SUMMARY FOR CHARACTERIZING RISK TO BIRDS AND MAMMALS FROM INORGANIC CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Receptor	Threshold of Concern	Summary of Results	Notes	Risk Characterization for Receptor
Overall Conclusions for Characterizing Risk to Populations of Birds and Mammals	**Population-level effects from exposure to metals were assessed by (1) estimating the fraction of each receptors habitat where risk was determined to be unacceptable on the basis of calculation of an HQ (dose/TRV_{high}) greater than 1.0, (2) consideration of the magnitude by which calculated doses exceeded the TRV_{high}, and (3) consideration of the specific factors (that is, elevated concentrations of metals in prey tissue and soil or sediment) responsible for HQs that exceed 1.0. For special status species, effects to individuals were also assessed.** **Population-level effects were not indicated for Mallard, Great Blue Heron, American Kestrel, Northern Harrier, gray fox, or river otters; all estimated ingested doses were less than the TRV_{high} for each of the inorganic COPECs. Some unacceptable risk may exist for California Black Rails utilizing areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7; zinc is the primary risk driver for the California Black Rail. Some unacceptable risk may exist for the Suisun Song Sparrow utilizing areas along the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches in Units 5 and 7; selenium is the primary risk driver for the Suisun Song Sparrow. Some unacceptable risk from arsenic may exist for individual salt marsh harvest mice in Unit 6; risk to populations of harvest mice was not indicated based on (1) findings of unacceptable risk at only five locations in Unit 6, and (2) the areawide HQ calculated for Unit 6 was only marginally greater than 1.0.**			

Notes: A summary of the approach used to estimate risk to birds and mammals from inorganic chemicals is provided in Table 88.

bgs Below ground surface
COPEC Chemical of potential ecological concern
HQ Hazard quotient (dose/TRV)
NA Not applicable
TRV_{high} High toxicity reference value

APPENDIX A

DOCUMENTS REVIEWED FOR 5-YEAR PERIODIC REVIEW ASSESSMENT
LITIGATION AREA,
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

(7 Pages)

Document Title	Author	Date
Initial Assessment Study of Naval Weapons Station (NWS) Concord, California	Ecology and Environment, Inc.	June 1983
Concord Confirmation Study, NWS Concord, California	Anderson Geotechnical Consultants, Inc., and Brown and Caldwell Consulting Engineers	September 1984
Final Report of Remedial Investigation of Contaminant Mobility at NWS Concord, California	U.S. Army Corps of Engineers (USACE), Waterways Experiment Station (WES) (cited as Lee and others 1986)	January 1986
Letter from California Regional Water Quality Control Board (RWQCB) to the Navy (with attachments) Regarding Soil and Water Pollution Investigations at NWS Concord, California	RWQCB	May 21, 1987
Tentative Order of RWQCB to Navy Regarding Site Cleanup Requirements	RWQCB	May 28, 1987
Conceptual Plans for Additional Investigation of Potential Surface Water and Groundwater Contamination on Parcels 571 through 576, 579D, and 581 at NWS Concord, California	RWQCB	October 5, 1987
Final Draft Report of Feasibility Study of Contamination Remediation at NWS Concord, California, Volume III: Figures	WES (cited as Lee and others 1988b)	April 1988
Final Report of Remedial Investigation of Contaminant Mobility at NWS Concord, California, Subtitle Appendix 2.5 – 1986/87 Data	WES (cited as Lee and others 1988a)	June 1988
Final Draft Report of Feasibility Study of Contamination Remediation at NWS Concord, California, Volume II: Biological Assessment	WES (cited as O'Neil 1988)	July 1988
Letter from U.S. Fish and Wildlife Service (USFWS) to the Navy Regarding Endangered Species Formal Consultation on Remediation of Heavy Metals Contamination at NWS Concord, California	USFWS	August 23, 1988

Document Title	Author	Date
Final Draft Report of Feasibility Study of Contamination Remediation at NWS Concord, California, Volume I: Remedial Action Alternatives	WES (cited as Cullinane and others 1988)	September 1988
Responses to Comments (on the public notice issued by the Navy for the RAP)	WES (Lee and others 1989b)	April 1989
Monitoring Plan for Contamination Remediation at NWS Concord, California	WES (Lee and others 1989a)	April 1, 1989
Record of Decision of Selection of Final Remedial Action Plan (RAP) for the Release and Threatened Release of Hazardous Substances on Parcels 572, 573, 574, 575, 576, 579D, and 581 at NWS, Concord California	Navy	April 6, 1989
Final RAP for the Release and Threatened Release of Hazardous Substances on Parcels 572, 573, 574, 575, 576, 579D, and 581 at NWS, Concord, California	Navy	April 6, 1989
Revised 100 Percent Remedial Design for Remedial Action Subsite (RASS) 4	Navy and PRC Environmental Management, Inc. (PRC)	June 11, 1990
Letter from U.S. Environmental Protection Agency (EPA) to Navy Regarding EPA review of RASS 1 Remedial Action 100 Percent Design Documents	EPA	July 2, 1990
Revised 100 Percent Remedial Design for RASSs 1, 2, and 3	Navy and PRC	July 3, 1990
Consent Decrees (seven decrees filed with former landowners)	Navy	1990 to 1991
Monitoring Plan Implementation, Site Monitoring Protocol, NWS Concord, California	Navy and PRC	June 7, 1991
Letter from Navy to USFWS Regarding Confirmation of Understanding Reached at July 2, 1991, Meeting About the USFWS Biological Opinion	Navy	July 12, 1991
Letter from Navy to USACE Regarding Additional Responses to USACE Comments on the Draft 100 Percent Plans and Specifications for RASSs 1 through 4 (confirmation of issues resolved with USFWS)	Navy	July 19, 1991

Document Title	Author	Date
Letter from Navy to USACE Regarding Responses to USACE's Comments on the Draft 100 Percent Plans and Specifications for RASSs 1 through 4	Navy	July 12, 1991
Letter from Navy to USACE Regarding Agency Coordination in Review of the Proposed Cleanup Activity at RASSs 1 through 4	Navy	July 28, 1991
Letter from Navy to USACE Regarding USACE's Remaining Concerns on the Draft 100 Percent Plans and Specifications for RASSs 1 through 4	Navy	July 30, 1991
Monitoring Plan Implementation, Monitoring Contingency Plan, Draft Final, NWS Concord, California	PRC	September 16, 1991
Draft Letter from RWQCB to the Navy Regarding Staff Concerns about the RAP for RASSs 1, 2, 3, and 4	RWQCB	October 23, 1991
Letter from Navy Counsel to RWQCB Regarding Comments on Plans and Specifications and Monitoring Protocol	Navy	November 12, 1991
Responses to Agency Comments of RASS 1, 2, and 3 100 Percent Plans and Specification	Navy	November 23, 1991
Letter from Navy Counsel to RWQCB Regarding Responding to RWQCB Letter dated October 23, 1991	Navy	November 23, 1991
Fax Letter from the Navy Counsel to PRC Summarizing Soil Sample Data in Nichols Creek Adjacent to Chemical and Pigment Company Property	Navy	December 10, 1991
Letter of Agreement Between U.S. Department of the Navy and San Francisco District USACE Concerning RASSs 1, 2, 3, and 4	USACE	January 13, 1992
Wetland Restoration and Revegetation Plan for RASSs 1, 2, and 3, NWS Concord, California	ASRC Contracting Company, Inc. (ACCI)	1993
NWS Concord Litigation Area Presentation Outline (contains site history chronology through 1992)	Navy	February 16, 1993

Document Title	Author	Date
EPA Comments Regarding Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Cleanup Activities at the Litigation Area Sites	EPA	June 28, 1993
Letter from EPA to Navy Regarding CERCLA Activities at NWS Concord Litigation Area	Navy	June 28, 1993
EPA Comments on the Site Monitoring Protocol at the Litigation Area Sites	EPA	September 21, 1993
Comments on Wetland Restoration and Revegetation Plan for RASSs 1, 2, and 3, NWS Concord, California	EPA	November 2, 1993
Draft Summary Report for the RASS 3 Hydrocarbon Site Investigation, NWS Concord, California	Navy an d PRC	November 4, 1993
Letter from the Agencies to the Navy Regarding Delineation of Areas Exceeding Total Threshold Limit Concentrations (TTLC) and Soluble Threshold Limit Concentrations (STLC) for RASS 4 Remediation	EPA	December 13, 1993
Letter from the Agencies to the Navy Regarding Delineation of Areas Exceeding TTLCs and STLCs cleanup criteria for RASSs 1, 2, and 3 Remediation	EPA	December 15, 1993
Meeting Minutes of January 18, 1994, meeting between Navy and EPA to Discuss Litigation Area Concerns	Navy	January 18, 1994
Final Responses to Comments on the Site Monitoring Protocol, NWS Concord, California	Navy and PRC	February 2, 1994
Draft Baseline Conditions Report Litigation Area Sites, Volume I: Text, Figures, and Appendices A through B	Navy and PRC	February 14, 1994
Draft Baseline Conditions Report Litigation Area Sites, Volume II: Appendices C through M	Navy and PRC	February 14, 1994
Responses to Agency Comments on Litigation Area Sites Monitoring Protocol	Navy and PRC	February 22, 1994

Document Title	Author	Date
Letter from the Navy to USFWS Regarding Construction of Tidal Slough Channels in RASSs 1 and 2	Navy	July 7, 1994
Remediation Summary Report RASS 4 Remedial Action	Navy and PRC	August 4, 1994
Notice of Preparation of Explanation of Significant Difference (ESD) RASSs 1 and 2 (letter)	Navy	August 8, 1994
Environmental Protection Plan	International Technology Corporation (IT)	August 8, 1994
Agency Comments on Draft ESD for RASSs 1 and 2	RWQCB	August 10, 1994
Materials Handling Plan, Revision 1	IT	August 12, 1994
Final ESD for RASSs 1 and 2	Navy and PRC	August 12, 1994
Remedial Action Report for RASS 3 (Contract N62474-90-C-1392)	ACCI	August 26, 1994
Hydrogeological and Analytical Data Compilation and Interpretation, Litigation Area Sites, NWS Concord, California	Navy and PRC	September 20, 1994
Comments on the Litigation Area Sites, Draft Hydrogeological and Analytical Data Compilation and Interpretation	EPA	October 25, 1994
Final Revegetation Monitoring Plan	H.T. Harvey and Associates	April 3, 1995
Final Year 1 Revegetation Monitoring Report	H.T. Harvey and Associates	May 7, 1996
Draft After Remediation (Year 1) Remedial Action Monitoring Report, Litigation Area, Volumes 1 and 2	Navy and PRC	May, 31 1996

Document Title	Author	Date
Tidal Influence Study and Postremediation Sampling Technical Memorandum	Navy and PRC	June 3, 1996
Draft Remedial Action Monitoring Report, After Remediation (Year 2) Sampling Locations (letter to agencies)	Navy and PRC	October 10, 1996
Draft Qualitative Ecological Risk Assessment (QEA) Report, Litigation Area, Volumes 1 through 3 (Volume 1: text, tables figures; Volume 2: Appendices A through K; Volume 3: Appendices L through T)	Navy and PRC	December 10, 1996
Responses to Comments on the Draft QEA Report, Litigation Area	Navy	May 15, 1997
After Remediation (Year 2) Remedial Action Monitoring Report, Litigation Area	Navy and Tetra Tech EM Inc. (TtEMI)	July 22, 1997
Technical Memorandum, Tidal Influence Study and Postremediation Groundwater Monitoring, Litigation Area	Navy and TtEMI	July 22, 1997
Final QEA Report, Litigation Area, Volumes 1 through 3 (Volume 1: text, tables figures; Volume 2: Appendices A through K; Volume 3: Appendices L through T)	Navy and TtEMI	September 2, 1997
Responses to Comments on the Technical Memorandum, Tidal Influence Study and Postremediation Groundwater Monitoring, Litigation Area	Navy and TtEMI	December 1, 1997
Draft After Remediation (Year 3) Remedial Action Monitoring Report, Litigation Area	Navy and TtEMI	February 2, 1998
Responses to Comments on the Final QEA Report	Navy and TtEMI	May 4, 1998
After Remediation (Year 4) Remedial Action Monitoring Report	Navy and TtEMI	1999
After Remediation (Year 5) Remedial Action Monitoring Report	Navy and TtEMI	2000

Document Title	Author	Date
Comments on the After Remediation (Year 5) Remedial Action Monitoring Report	EPA, National Oceanic and Atmospheric Administration	February 24, 2000
Additional Comments on the After Remediation (Year 5) Remedial Action Monitoring Report	EPA	July 31, 2000
Draft Final Work Plan for the Five-year Periodic Review Assessment, Litigation Area	Navy and TtEMI	November 22, 2000
Comments on the Draft Final Work Plan for the Five-year Periodic Review Assessment, Litigation Area	EPA	January 12, 2001

APPENDIX B

SITE INSPECTION REPORTS AND SITE PHOTOS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
LITIGATION AREA
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

CONTENTS

APPENDIX B-1 **FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST**

Attachment B-1.1: Site Inspection Team Roster, July 27, 2001

Attachment B-1.2: Site Inspection Tour Route, July 27, 2001

APPENDIX B-2 **PHOTOGRAPHS FROM JULY 27, 2001 SITE INSPECTION**

APPENDIX B-3 **RWQCB REPORT OF CHEMICAL SPILL FROM UNATTENDED ISOLATED RAILROAD CAR**

Attachment B-3.1: Analytical Results of White Powder Spill from Railroad Car Collected by RWQCB on July 27, 2001

Attachment B-3.2: Analytical Results of Total Metals in Surface Water Collected near Spill Site by RWQCB on September 7, 2001

APPENDIX B-4 **PHOTOGRAPHS FROM FOLLOW-UP SITE VISIT BY TETRA TECH EM INC., SEPTEMBER 5, 2001**

APPENDIX B-5 **AREA OF DISTRESSED VEGETATION IN RASS 1 ACTIVE REMEDIATION AREA, NOVEMBER 16, 2001**

APPENDIX B-1

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

Five-Year Review Site Inspection Checklist[a]

Litigation Area, Naval Weapons Station Seal Beach Detachment Concord

I. SITE INFORMATION	
Site Name: Litigation Area; includes Remedial Action Subsites (RASS) 1, 2, 3 and 4.	**Date of Inspection:** July 27, 2001
Location and Region: Naval Weapons Station Seal Beach Detachment Concord, Port Chicago Highway Concord (Contra Costa County), California 94520	**EPA ID**: CA 7170024528 **Owner/operator:** United States of America Department of the Navy
Agency, office, or company leading the five-year review: Engineering Field Activity West (U.S. Navy) supported by Tetra Tech EM, Inc (TtEMI).	**Weather/Temperature:** Sunny and breezy / approx 85 degrees

Remedy Includes (check all that apply)

- ☐ Land fill cover/containment
- ☒ Access Controls
- ☐ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- ☒ Other: 1) Excavation and disposal of most contaminated soil in each RASS (active remediation areas) followed by grading and revegetation; 2) Monitoring of areas not remediated.

Attachments: ☒ Inspection team roster included as Attachment B-1.1 ☒ Site map included as Attachment B-1.2
(Note: Site tour photos provided in Appendix B-2. Report by Regional Water Quality Control Board on observed railcar spill included as Appendix B-3. Photos from a follow-up site visit by TtEMI on September 3 include as Appendix B-4. A map of the area of distressed vegetation observed is included as Appendix B-5.)

II. INTERVIEWS

No interviews were conducted as site manager and agency staff actively participated in the five year review.

1. **O&M site manager** N/A _____ _____ _____
   Name Title Date

   Interviewed ☐ at site ☐ at office ☐ by phone Phone No. _____
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** N/A _____ _____ _____
   Name Title Date

   Interviewed ☐ at site ☐ at office ☐ by phone Phone No. _____
   Problems, suggestions; ☐ Report attached _____

a U.S. Environmental Protection Agency. 2001. "Comprehensive Five-Year Review Guidance." EPA 540-R-01-007. June.

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply:

Agency N/A
Contact Name Title Date Phone No.
Problems, suggestions; ☐ Report attached

Agency
Contact Name Title Date Phone No.
Problems, suggestions; ☐ Report attached

Agency
Contact Name Title Date Phone No.
Problems, suggestions; ☐ Report attached

Agency
Contact Name Title Date Phone No.
Problems, suggestions; ☐ Report attached

4. **Other interviews** (optional) ☐ Report attached

N/A

III. ONSITE DOCUMENTS AND RECORDS VERIFIED (check all that apply)

1.	**O&M Documents**			
	☐ O&M manual (see remarks)	☐ Readily available	☐ Up to date	☒ N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	☒ N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	☒ Readily available	☒ Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits _____	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal facility in-house ☒ Contractor for Federal facility
☐ Other _____

2. **O&M Cost Records**

☒ Readily available ☒ Up to date
☐ Funding mechanism/agreement in place
☒ Original O&M cost estimate N/A ☐ Breakdown attached

Cost breakdown provided in Section 7.1.2 of the Five-Year Periodic Review Assessment report.

From _____ (Date) To _____ (Date) _____ (Total Cost) ☐ Breakdown attached
From _____ (Date) To _____ (Date) _____ (Total Cost) ☐ Breakdown attached
From _____ (Date) To _____ (Date) _____ (Total Cost) ☐ Breakdown attached
From _____ (Date) To _____ (Date) _____ (Total Cost) ☐ Breakdown attached
From _____ (Date) To _____ (Date) _____ (Total Cost) ☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: The Navy has spent approximately $19 million on remediation and monitoring of the site (costs cited are post ROD and do not include costs for the five year review). No O&M cost estimates were available for comparison.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☒ Location shown on site map ☒ Gates secured ☐ N/A

Remarks Access gate to RASS 4 on Port Chicago Highway was broken open; visible signs of motorcycle tracks through RASS 4 confirm trespassing has occurred. U.S. Army security was informed and locks were replaced the afternoon of July 27, 2001.
Fencing around RASSs 1, 2, and 3 can be breached due to presence of railroad tracks that bisect the site and low height of fencing.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks Signs around Navy property border announce "Warning Restricted Area: Keep Out". There are no signs warning of the presence of hazardous wastes onsite.
U.S. Army security personnel patrol the area and provide an added measure of security for the site.

C. Institutional Controls: N/A

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

Type of monitoring (e.g., self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone No.

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions ☐ Report attached

2. **Adequacy** ☐ ICs are adequate ☐ ICs are not adequate ☐ N/A

Remarks _____

D. General

1. **Vandalism/trespassing** ☒ Location shown on site map ☐ No vandalism evident

Remarks Access gate to RASS 4 on Port Chicago Highway was broken open; visible signs of motorcycle tracks through RASS 4 confirm trespassing has occurred. U.S. Army security was informed and locks were replaced the afternoon of July 27, 2001.

2. **Land use changes onsite** ☒ N/A

Remarks _____

3. **Land use changes offsite** ☐ N/A

Remarks Since the time of the remedy, the Chemical and Pigment Plant has gone bankrupt and closed. Some property ownership changes have occurred at the General Chemical facility. Notes and observations regarding potential offsite ongoing sources of contamination are recorded in the "other observations" section below.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☒ Location shown on site map ☐ Roads adequate ☐ N/A

Remarks Roads in the area are in adequate condition. A dirt road used to access RASS 3 during remediation is now in poor condition as it has been overgrown by weeds. Because the road is infrequently used, no road maintenance is recommended.

B. Other Site Conditions

Remarks See notes on site tour in "other observations" below.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. Landfill Surface

1. **Settlements** (Low spots) ☐ Location shown on site map ☐ Settlement not evident

Areal extent _____ Depth _____

Remarks _____

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident

Lengths _____ Widths _____ Depths _____

Remarks _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident

Areal extent _____ Depth _____

Remarks _____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident

Areal extent _____ Depth _____

Remarks _____

5. **Vegetative Cover** ☐ Grass ☐ Cover proper established ☐ No signs of stress

☐ Trees/Shrubs (indicate size and locations on a diagram)

Remarks _____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A

Remarks _____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident

Areal extent _____ Height _____

Remarks _____

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Area extent _____

☐ Ponding ☐ Location shown on site map Area extent _____

☐ Seeps ☐ Location shown on site map Area extent _____

☐ Soft subgrade ☐ Location shown on site map Area extent _____

Remarks _____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability

Areal extent _____ Height _____

Remarks _____

B. Benches ☐ Applicable ☐ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or Okay

Remarks _____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or Okay

Remarks _____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or Okay

Remarks _____

C. Letdown Channels ☐ Applicable ☐ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep slide slope of the cover and allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement

Areal extent _____ Depth _____

Remarks _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation

Material type _____ Areal extent _____

Remarks _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion

Areal extent _____ Depth _____

Remarks _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent _____ Depth _____
Remarks _____

5. **Obstructions** Type _____ ☐ No obstructions
☐ Location shown on site map _____
Size _____
Remarks _____

6. **Excessive Vegetative Growth** Type _____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent _____
Remarks _____

D. Cover Penetrations ☐ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks _____

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks _____

3. **Monitoring Wells (**within surface area of landfill)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks _____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks _____

5. **Settlement Monuments** ☐ Located ☐ Routinely sampled ☐ N/A
Remarks _____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs O&M
   Remarks _____

2. **Gas Collection Wells, Manifolds, Piping**
   ☐ Good condition ☐ Needs O&M
   Remarks _____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs O&M ☐ N/A
   Remarks _____

F. Cover Drainage Layer ☐ Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
   Remarks _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
   Remarks _____

G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A

1. **Siltation** Areal extent _____ Depth _____ ☐ N/A
   ☐ Siltation not evident
   Remarks _____

2. **Erosion** Areal extent _____ Depth _____ ☐ Erosion Not evident
   Remarks _____

3. **Outlet Works** ☐ Functioning ☐ N/A
   Remarks _____

4. **Dam** ☐ Functioning ☐ N/A
   Remarks _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformation** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement _____ Vertical displacement _____
   Rotational displacement _____
   Remarks
   _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks _____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
Areal extent _____ Depth _____
Remarks _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Areal extent _____ Type _____
Remarks _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent _____ Depth _____
Remarks _____

4. **Discharge Structure** ☐ Functioning ☐ N/A
Remarks _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent _____ Depth _____
Remarks _____

2. **Performance Monitoring** Type of monitoring _____
☐ Performance not monitored
Frequency _____ ☐ Evidence of breaching
Head differential _____
Remarks _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition ☐ All required wells located ☐ Needs O&M ☐ N/A
Remarks _____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition ☐ Needs O&M
Remarks _____

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks _____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Collection Structures, Pumps, and Electrical**
☐ Good condition ☐ Needs O&M
Remarks _____

2. **Surface Water Collection Systems Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition ☐ Needs O&M
Remarks _____

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks _____

C. Treatment System ☐ Applicable ☐ N/A

1. **Treatment Train** (check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters _____
☐ Additive (e.g., chelation agent, flocculent) _____
☐ Others _____
☐ Good condition ☐ Needs O&M
☐ Sampling ports property marked and functional
☐ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☐ Quantity of groundwater treated annually _____
☐ Quantity of surface water treated annually _____
Remarks _____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☐ Good Condition ☐ Needs O&M
Remarks _____

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs O&M

Remarks _____

4. **Discharge Structure and Appurtenances**

☐ N/A ☐ Good Condition ☐ Needs O&M

Remarks _____

5. **Treatment Building(s)**

☐ N/A ☐ Good Condition (esp. roof and doorways ☐ Needs repair

☐ Chemicals and equipment properly stored

Remarks _____

6. **Monitoring Wells** (pump and treatment remedy)

☒ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☒ Good condition

☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks Groundwater monitoring was conducted before and immediately after remediation; pump and treat is not part of the remedy.

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks _____

X. OTHER REMEDIES

(If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction).

Site Restoration Efforts: The success of the site revegetation efforts was documented in the After Remediation (Year 5) Remedial Action Monitoring Report. In general, site restoration has been successful and has met success criteria established in the revegetation plan, with some exceptions. Site revegetation in RASS 1 was very successful with high percent cover of native vegetation (pickleweed) and presence of special status species that have recolonized the actively remediated area. In RASS 2, success criteria were not met in all parts of the active remediation area as surface elevation and hydrology were not consistent with plant requirements. No success critiera were identified for the reseeding effort in RASS 3; RASS 3 is currently composed of a mix of native and non-native plants. In RASS 4, success critiera for survival of coyote bush was not met; absence of topsoil and competition with weedy species is the likely reason.

XI. OVERALL OBSERVATIONS
A. Implementation of the Remedy
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions. etc.). **These issues are summarized in Section 7.1 of the five year periodic review assessment report**.
B. Adequacy of O&M
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. **These issues are summarized in Section 7.1 of the five year periodic review assessment report.**
C. Early Indicators of Potential Remedy Failure
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. **These issues are summarized in Section 7.1 of the five year periodic review assessment report.**
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. **These issues are summarized in Section 7.1 of the five year periodic review assessment report.**

E. Other Observations and Notes from the Site Tour (this section added to the EPA 2001 template)

Notes by Mary Gleason, TtEMI project manager, on the July 27, 2001 site inspection tour are provided below.

The tour participants (see Attachment B-1.1) met at Badge and Pass office for a briefing and then proceeded to the Litigation Area field trailer site on Nichols Road. The approximate walking tour route is shown on Attachment B-1.2; a summary of observations made at points of interest is provided below. Photographs taken during the site visit are provided in Appendix B-2.

Location #1: Border of Chemical and Pigment Company (CPC) and Nichols Creek: The group visited the northwest corner of the CPC facility and observed evidence of active soil erosion and surface water runoff along the border of Nichols Creek and CPC. The former surface impoundment area had signs that there had been standing water at some time in the recent past, with patterns of sedimentation on the paved surface that indicated surface water runoff and erosion. The bank of Nichols Creek was eroded along parts of the CPC boundary, and clear evidence of surface drainage from the CPC site to Nichols Creek was noted.

Rik Lantz (TtEMI) discussed groundwater contamination beneath the CPC site, and noted that extremely high concentrations of zinc were observed in wells at the perimeter of the property, upgradient from Navy property. Field equipment (wires and probes) present at a groundwater well on the northwest corner of CPC indicated possible past groundwater monitoring, but the equipment was disconnected and appeared not to be functioning. The soil in Nichols Creek was saturated but there was no standing water.

A tree crew was cutting down several large eucalyptus trees in the front (east) side of the CPC facility. The large stockpile of contaminated soil is still covered with plastic and tires; however, the plastic had large rips in many places**.**

Jim Pinasco of the Department of Toxic Substances Control (DTSC) said that the permitting office in Berkeley is working on this facility. Laurent Meillier of the Regional Water Quality Control Board (RWQCB) said he would find out about any existing RWQCB orders against the facility.

Locations #2a and 2b: Erosional areas along Nichols Creek: The group observed large erosional areas on railroad property along Nichols Creek and smaller areas of slumping of the creek bank on Navy property. Several feet of exposed soils beneath the culverts that pass beneath the railroad tracks near the northwest corner of CPC indicate extensive soil erosion in this area.

The group stopped briefly at monitoring well 3MG11 in remedial action subsite (RASS) 3 and Rik Lantz (TtEMI) talked about the groundwater, geology, and sand lenses in the area. The flat topography and alluvial fan at the bottom of Nichols Creek where it meets the RASS 3 wetland were noted.

Location #3: Railcar spill between RASS 2 and 3: While traversing along the Southern Pacific Transportation Corporation railway between RASS 2 and 3, the group noticed a railcar on a siding near General Chemical was leaking. A fine white powder was piling up under the car and was also seen further along the tracks. Laurent Meillier (RWQCB) provided a more detailed report of the incident that is included as Appendix B-3. Mr. Meillier spoke to a General Chemical company spokesperson who indicated that the material was aluminum; the group discussed how this could explain the elevated aluminum measured in RASS 1 surface water samples in October 2000. The RWQCB later analyzed a sample from the spill and found it contained 130,000 milligrams per kilogram (mg/kg) aluminum or 13% aluminum by mass; the sample also contained 1.1 mg/kg beryllium and 41 mg/kg zinc. The RWQCB issued a 13267 letter to General Chemical and is expecting a response by September 10, 2001.

E. Other Observations and Notes from the Site Tour (this section added to the EPA 2001 template)

Notes by Mary Gleason, TtEMI project manager, on the July 27, 2001 site inspection tour are provided below.

Location #4: RASS 3 ponded wetland: The group stood on the railroad trestle and observed the ponded wetland in RASS 3, now extensively filled with cattails and other vegetation. The wetland drains north into a mosquito ditch in RASS 1 under the railroad trestle and joins the upper reaches of Lost Slough; the tide was going out during the visit and water was observed moving north under the railroad trestle. A small berm of soil beneath the railroad trestle that partially impounds water in the RASS 3 pond was noted.

Location #5: Unit 11 Slough in RASS 1: The group crossed several mosquito ditches in the wetland of RASS 1 to reach the Unit 11 portion of Lost Slough where it passes under a fence. Water level was high in the slough, though not overtopping the bank. The group discussed the metals concentrations in sediments in this side arm of Lost Slough and how the hydrology could create a "sink" for contamination in this area. Rik Lantz (TtEMI) talked about the core samples and the vertical contamination profiles in the slough, marsh surface and ditches.

Location #6: RASS 2 and railroad company remediation pits: While walking along the ATSF railroad, the group observed the incomplete remediation efforts taken by ATSF on railroad property in RASS 2. Extensive soil removal left large pits; the area has not been graded and marsh vegetation has not been restored. Mary Gleason (TtEMI) told the group that these pits fill up with water during the wet season and represent an exposure pathway for aquatic and avian receptors.

Location #7: RASS 1 active remediation area, mosquito ditch: The group walked along the edge of the active remediation area and the unremediated area in RASS 1, viewing several large patches of soft-birds beak (*Cordylanthus mollis* ssp. *mollis*) and several mosquito ditches. Percent cover of pickleweed and other native plants was very high (almost 100%) in the remediated area of RASS 1. Sedimentation, which was expressed by shallow ditch depths in the distal ends of mosquito ditches, was noted.

Location #8: Berm between General Chemical and Navy property (RASS 1): The group crossed the remediated area of RASS 1 and climbed the earthern berm separating Navy property and General Chemical/Allied Signal/Honeywell properties. Phillip Ramsey, U.S. Environmental Protection Agency (EPA), noted the stark difference between the Navy's restored wetland and the barren lagoons on the chemical company property. Mary Gleason informed the group that these lagoons are full in the wet season and often have many shorebirds and wading birds present. The group noted that General Chemical is under voluntary compliance and is currently conducting a human health risk assessment and an ecological risk assessment. Arsenic, zinc, aluminum, and pH are just some of the chemicals of concern at the neighboring property.

Phillip Ramsey and Mary Gleason noted an area of distressed and dead vegetation at the base of the berm on the Navy's side (in an actively remediated area that formerly was healthy vegetation) between the berm and groundwater monitoring well 1AGO3 (see map in Attachment B-1.2). The pickleweed in this area was bright orange and the soil was black in color. This area of distressed vegetation was immediately adjacent to the berm, including part of the slope of the berm, and was surrounded by healthy vegetation. The area of distressed vegetation was approximately 120 long by 10 feet wide.

The group noted several burrows, including larger fox burrows, in the earthern berm.

E. Other Observations and Notes from the Site Tour (this section added to the EPA 2001 template)
Notes by Mary Gleason, TtEMI project manager, on the July 27, 2001 site inspection tour are provided below.
Locations #9a and b: RASS 4: The group entered RASS 4 through a gate that was not locked along Port Chicago Highway (location 9a). The group walked west through the coyote bush and found a large motorcycle trail through the middle of RASS 4, indicating the presence of trespassers and failure of access controls. At the west end of the trail, another gate to Port Chicago Highway was broken open, allowing access to trespassers (Location 9b). Bare, compacted soils were noted along the motorcycle trail in the actively remediated area of RASS 4. At the eastern end of the motorcycle trail there was evidence of motorcycles being driven in the wetland area of RASS 4. Rudy Pontemayor, the facility environmental coordinator, immediately alerted base security; the locks were replaced and gates secured that afternoon.

ATTACHMENT B-1.1

SITE INSPECTION TEAM ROSTER, JULY 27, 2001

Site Inspection Participants:

Gilbert Rivera, Engineering Field Activities West

Phillip Ramsey, U.S. Environmental Protection Agency (EPA)

Sonce de Vries, EPA and U.S. Fish and Wildlife Service

James Pinasco, California Department of Toxic Substances Control (DTSC)

John Christopher, DTSC

Laurent Meillier, California Regional Water Quality Control Board

James Hardwick, California Department of Fish and Game

Rudy Pontemayor, Environmental Site Manager, Naval Weapons Station, Seal Beach Detachment, Concord

Mary Gleason, Tetra Tech EM Inc. (TtEMI)

Rik Lantz, TtEMI

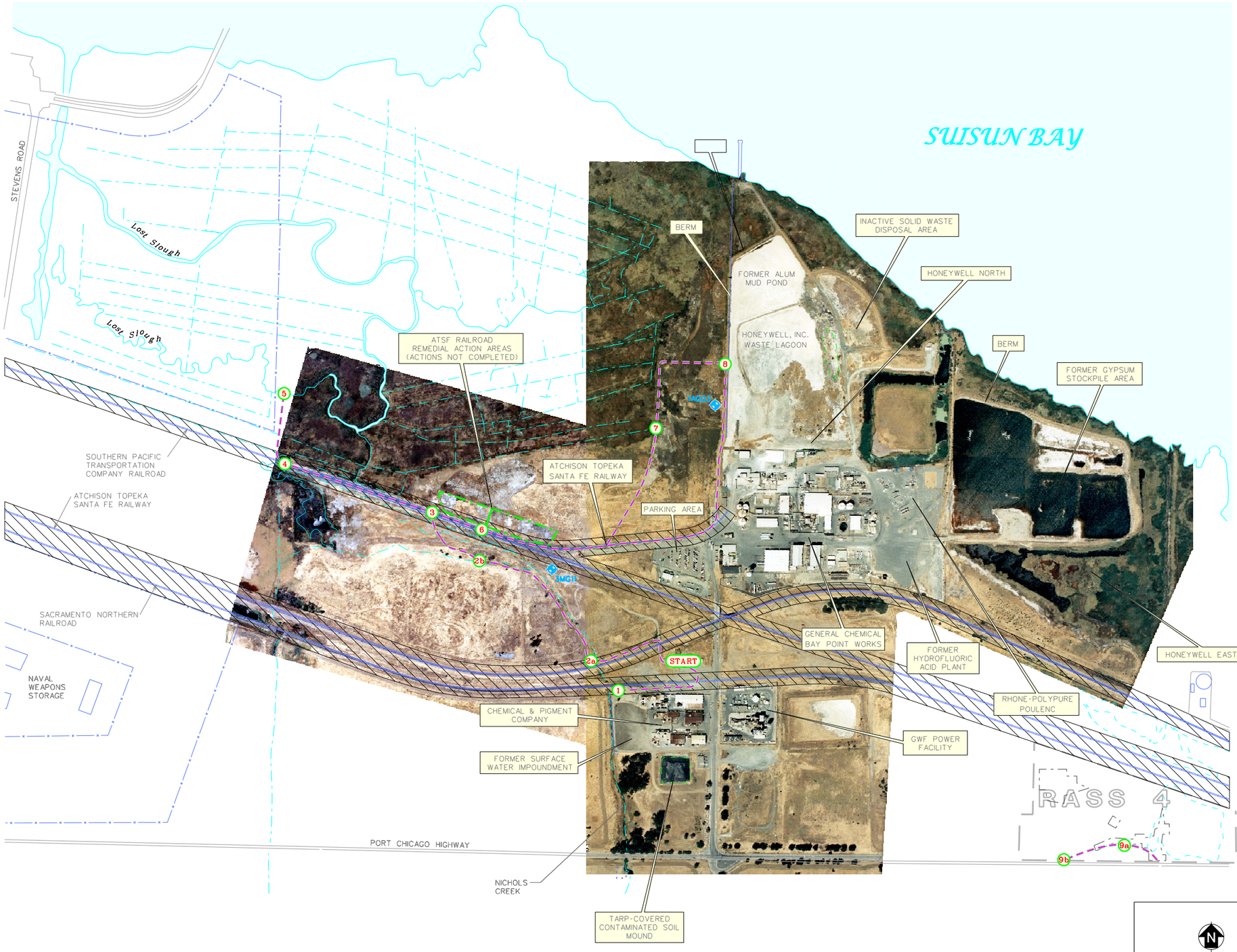
Lynne Haroun, TtEMI

Ray Bienert, TtEMI

Hilary Waites, TechLaw, Inc.

ATTACHMENT B-1.2

SITE INSPECTION TOUR ROUTE, JULY 27, 2001



LEGEND

- BUILDING
- ROAD
- FENCE
- SLOUGH
- MOSQUITO DITCH
- RAILROAD TRACK WITH 50 FT RIGHT OF WAY ON EITHER SIDE
- (1) LOCATION NUMBERS DESCRIBED IN SITE INSPECTION TOUR CHECKLIST
- GROUNDWATER MONITORING WELL

NOTE:
LOCATION OF NEIGHBORING PROPERTIES BASED ON FILE REVIEW AND 1999 AERIAL PHOTOGRAPH.

Tetra Tech EM Inc.

N

0 150 300 450 600
SCALE IN FEET

LITIGATION AREA
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

ATTACHMENT B-1.2
SITE INSPECTION TOUR ROUTE
JULY 27, 2001

10/09/2002 j:\concord1\dgn\Cto373\Site_Inspect_Tour_Route.dgn

APPENDIX B-2

PHOTOGRAPHS FROM JULY 27, 2001 SITE INSPECTION

Photograph No. 1: July 27, 2001, Site Inspection Tour Participants. From left to right: Gilbert Rivera (EFA West), Laurent Meillier (RWQCB), Jim Pinasco (DTSC), Mary Gleason (TtEMI), Jim Hardwick (CDFG), Hilary Waites (TechLaw), Sonce deVries (USFWS/EPA), Lynne Haroun (TtEMI), Phillip Ramsey (EPA), Rik Lantz (TtEMI), Rudy Pontemayor (Naval Weapons Station SBD Concord), John Christopher (DTSC); photographed by Ray Bienert (TtEMI)

Photograph No. 2. Signs and Fence Restricting Access at RASS 3 Border.

Photograph No. 3. Chemical and Pigment Company (CPC) Facility. Closed facility bordering Nichols Creek in RASS 3, as viewed through fence from Navy property. Tarp-covered stockpile of contaminated soil can be observed in the distance, and evidence of surface water runoff is present in foreground (particulate runoff coming from white pipe onto paved roadway leading to Nichols Creek).

Photograph No. 4. Evidence of Runoff and Erosion from Chemical and Pigment Company Along Edge of Nichols Creek. Fence separates CPC property from Navy property.

Photograph No. 5. Evidence of Soil Erosion in Contaminated Area of Nichols Creek in Railroad Right-of-Way in RASS 3.

Photograph No. 6. Leaking Chemical from Train Parked on Spur between RASS 3 and RASS 2. Spill was reported by Laurent Meillier (RWQCB), and a sample was collected for analysis. The material was subsequently found to contain 130,000-ppm aluminum (or 13-percent aluminum by mass) as well as 1.1-ppm beryllium and 41-ppm zinc.

Photograph No. 7. Inspecting the Unit 11 Side Arm of the Lost Slough in RASS 1.

Photograph No. 8. Pits on Railroad Property in RASS 2 Remaining After Incomplete Remediation Efforts by ATSF railroad.

Photograph No. 9. Approaching the RASS 1 Active Remediation Area. The restored area, mostly 100 percent cover of pickleweed (darker vegetation), is directly ahead of walking participants.

Photograph No. 10. Berm Separating Honeywell Waste Lagoons (on left) from the Navy's Active Remediation Area in RASS 1 (on right).

Photograph No. 11. Area of Distressed and Dead Vegetation in the RASS 1 Active Area, Along the Berm Separating RASS 1 from the Waste Lagoons on the Honeywell and General Chemical Company Properties.

APPENDIX B-3

RWQCB REPORT OF CHEMICAL SPILL FROM UNATTENDED ISOLATED RAILROAD CAR

California Regional Water Quality Control Board
San Francisco Bay Region

Winston H. Hickox
Secretary for Environmental Protection

1515 Clay Street, Suite 1400, Oakland, California 94612
Phone (510) 622-2300 • FAX (510) 622-2460

Gray Davis
Governor

TO: Curtis Scott
Division Chief
SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

FROM: Laurent Meillier
Remedial Project Manager
SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

DATE: August 1, 2001

SUBJECT: REPORT OF CHEMICAL SPILL FROM UNATTENDED ISOLATED RAILROAD CAR EAST OF THE CONCORD NAVAL WEAPON STATION, CONTRA COSTA COUNTY, CALIFORNIA.

On July 27 2001 at 12:33 pm, while inspecting the litigation area of the Concord Naval Weapon Station with, Gilbert Rivera (U.S. Navy), Philip Ramsey (EPA), Mary Gleason (TetraTech), Jim Hardwick (California Fish and Game) and Jim Pinasco (DTSC), we came upon a railroad tank car actively spilling white powder. About 1/2 m^3 of unidentified material had escaped the railroad tank car by the time we came upon the scene. GPS coordinates were obtained using a unit borrowed from Jim Hardwick and were found to be at: N 38°02.827 and W 121°59.652. The spill was found between RASS 2 and RASS 3 (Navy denomination in their report entitled: "Draft Five-Year Review Assessment for litigation Area Naval Weapons Station, Seal Beach Detachment Concord, California"), West of Nichols Road about 2,400 feet south of Suisun Bay. The tracks are located between tidal wetlands on land owned by the Concord Naval Weapons Station. Four digital pictures (enclosed) of this spill were taken. A sample of the spilled product spilling was placed in a plastic bottle and is available for analysis upon request.
I walked the railroad tracks in a easterly direction from the spilling railroad car. Periodically, there was white powder which appeared to be the same as that spilling from the railcar on the ground between and in the close vicinity of the tracks. I was able to back track to where the railroad cars must have been emptied on the General Chemical Company property 2,100 feet east of the spilling rail car. I reached the security guard on duty at the working facility. She (on duty security guard) subsequently notified the parties working at the General Chemical Company. Four members of personnel from the General Chemical Company came to meet me. I physically pointed out the railroad car spilling product. They communicated that the spilled product was aluminum hydrate. They told me that they would take care of the problem.

Enclosed: four digital pictures taken on site during active spill.

#1: Railroad Car Actively spilling product

#2: Bottom of railroad car spilling product

#3: Railroad car identification (front)

#4: Railroad car identification (back)

Buhl, K.J. 2000. The acute toxicity of waterborne inorganic contaminants to the Rio Grande silvery minnow (Hybognathus amarus) and fathead minnow (Pimephales promelas) in a water quality simulating that in the Rio Grande. Report to the U.S. Fish and Wildlife Service, Albuquerque, NM. ? pages. (in preparation: Contains information on the toxicity of aluminum, ammonia, arsenic, chlorine, copper, nitrate, and an environmentally relevant mixture of the chemicals except for chlorine).

Firling, C.E., T.A. Hill, and A.R. Severson. Aluminum toxicity perturbs long bone calcifi-cation in the embryonic chick. Archives of Toxicology, Vol. 73 issue 7 (1999), pp. 359—366

THE ROLE OF ALUMINUM IN BIOLOGICAL DAMAGE

Aluminum enters lakes and streams as it is released from acidif ied terrestrial soils and lake sediments. Two form of aluminum, ionic aluminum and aluminum hydroxide, are toxic to fish species, while other aquatic organisms appear to be less susceptible to aluminum toxicity. Aluminum toxicity only occurs at pH values less than 6.0.

In forests, agricultural lands, and wetlands acid rain is responsible for mobilization of soil aluminum which causes root damage and in leaching nutrients from plant foliage. Polluted fogs and mists expose terrestrial plants to high acid concentrations, sometimes causing direst foliar damage.

The increase in haze in the Arctic and temperate regions are also believed to be caused by long-range transport of sulfur.

ATTACHMENT B-3.1

ANALYTICAL RESULTS OF WHITE POWDER SPILL FROM RAILROAD CAR COLLECTED BY RWQCB ON JULY 27, 2001

Sequoia Analytical

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FAX (707) 792-0342
www.sequoialabs.com

29 August, 2001

Laurent Meillier
CRWQCB - San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

RE: Litigation Area Concord
Sequoia Report: P108072 RECREATE

Enclosed are the results of analyses for samples received by the laboratory on 08/03/01 13:00. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Mark Shipman
Project Manager

CA ELAP Certificate #2374

Sequoia Analytical

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 08/22/01 14:16

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MEIL001	P108072-01	Other (W)	07/27/01 12:33	08/03/01 13:00

Sequoia Analytical - Petaluma

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Mark Shipman, Project Manager

Sequoia Analytical

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www.sequoialabs.com

CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 08/22/01 14:16

Total Metals by EPA 6000/7000 Series Methods

Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MEIL001 (P108072-01) Other (W) Sampled: 07/27/01 12:33 Received: 08/03/01 13:00									
Aluminum	**130000**	500	mg/kg	1	1080111	08/10/01	08/20/01	EPA 6010B	
Antimony	ND	60	"	"	"	"	"	"	
Arsenic	ND	99	"	"	"	"	"	"	
Barium	ND	9.9	"	"	"	"	"	"	
Beryllium	**1.1**	0.99	"	"	"	"	"	"	
Cadmium	ND	9.9	"	"	"	"	"	"	
Chromium	ND	9.9	"	"	"	"	"	"	
Cobalt	ND	6.9	"	"	"	"	"	"	
Copper	ND	9.9	"	"	"	"	"	"	
Lead	ND	74	"	"	"	"	"	"	
Molybdenum	ND	20	"	"	"	"	"	"	
Nickel	ND	30	"	"	"	"	"	"	
Selenium	ND	99	"	"	"	"	"	"	
Silver	ND	6.9	"	"	"	"	"	"	
Thallium	ND	99	"	"	"	"	"	"	
Vanadium	ND	9.9	"	"	"	"	"	"	
Zinc	**41**	30	"	"	"	"	"	"	

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 08/22/01 14:16

Total Metals by EPA 6000/7000 Series Methods - Quality Control

Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1080111 - EPA 3050B										
Blank (1080111-BLK1)				Prepared & Analyzed: 08/10/01						
Aluminum	ND	50	mg/kg							
Antimony	ND	6.0	"							
Arsenic	ND	10	"							
Barium	ND	1.0	"							
Beryllium	ND	0.10	"							
Cadmium	ND	1.0	"							
Chromium	ND	1.0	"							
Cobalt	ND	0.70	"							
Copper	ND	1.0	"							
Lead	ND	7.5	"							
Molybdenum	ND	2.0	"							
Nickel	ND	3.0	"							
Selenium	ND	10	"							
Silver	ND	0.70	"							
Thallium	ND	10	"							
Vanadium	ND	1.0	"							
Zinc	ND	3.0	"							
LCS (1080111-BS1)				Prepared & Analyzed: 08/10/01						
Aluminum	499	50	mg/kg	500		99.8	80-120			
Antimony	46.0	6.0	"	50.0		92.0	80-120			
Arsenic	48.7	10	"	50.0		97.4	80-120			
Barium	50.2	1.0	"	50.0		100	80-120			
Beryllium	5.03	0.10	"	5.00		101	80-120			
Cadmium	4.94	1.0	"	5.00		98.8	80-120			
Chromium	50.5	1.0	"	50.0		101	80-120			
Cobalt	48.0	0.70	"	50.0		96.0	80-120			
Copper	49.6	1.0	"	50.0		99.2	80-120			
Lead	48.9	7.5	"	50.0		97.8	80-120			
Molybdenum	47.6	2.0	"	50.0		95.2	80-120			
Nickel	49.6	3.0	"	50.0		99.2	80-120			
Selenium	48.6	10	"	50.0		97.2	80-120			
Silver	4.17	0.70	"	5.00		83.4	80-120			
Thallium	49.3	10	"	50.0		98.6	80-120			
Vanadium	49.2	1.0	"	50.0		98.4	80-120			
Zinc	47.2	3.0	"	50.0		94.4	80-120			

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 08/22/01 14:16

Total Metals by EPA 6000/7000 Series Methods - Quality Control

Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1080111 - EPA 3050B										
Matrix Spike (1080111-MS1)		**Source: P108062-02**		Prepared & Analyzed: 08/10/01						
Aluminum	11900	47	mg/kg	472	9800	445	75-125			QM-4X
Antimony	23.1	5.7	"	47.2	ND	48.9	75-125			QM-07
Arsenic	49.4	9.4	"	47.2	ND	95.3	75-125			
Barium	164	0.94	"	47.2	120	93.2	75-125			
Beryllium	4.95	0.094	"	4.72	0.40	96.4	75-125			
Cadmium	4.60	0.94	"	4.72	ND	97.5	75-125			
Chromium	77.2	0.94	"	47.2	31	97.9	75-125			
Cobalt	49.8	0.66	"	47.2	9.5	85.4	75-125			
Copper	62.2	0.94	"	47.2	17	95.8	75-125			
Lead	47.3	7.1	"	47.2	ND	89.6	75-125			
Molybdenum	42.4	1.9	"	47.2	ND	87.1	75-125			
Nickel	89.2	2.8	"	47.2	43	97.9	75-125			
Selenium	40.1	9.4	"	47.2	ND	85.0	75-125			
Silver	3.54	0.66	"	4.72	ND	75.0	75-125			
Thallium	45.0	9.4	"	47.2	ND	90.9	75-125			
Vanadium	76.6	0.94	"	47.2	32	94.5	75-125			
Zinc	85.8	2.8	"	47.2	47	82.2	75-125			
Matrix Spike Dup (1080111-MSD1)		**Source: P108062-02**		Prepared & Analyzed: 08/10/01						
Aluminum	11900	45	mg/kg	446	9800	471	75-125	0.00	35	QM-4X
Antimony	21.5	5.4	"	44.6	ND	48.2	75-125	7.17	35	QM-07
Arsenic	46.1	8.9	"	44.6	ND	93.5	75-125	6.91	35	
Barium	156	0.89	"	44.6	120	80.7	75-125	5.00	35	
Beryllium	4.61	0.089	"	4.46	0.40	94.4	75-125	7.11	35	
Cadmium	4.22	0.89	"	4.46	ND	94.6	75-125	8.62	35	
Chromium	78.4	0.89	"	44.6	31	106	75-125	1.54	35	
Cobalt	47.4	0.62	"	44.6	9.5	85.0	75-125	4.94	35	
Copper	58.3	0.89	"	44.6	17	92.6	75-125	6.47	35	
Lead	44.9	6.7	"	44.6	ND	89.5	75-125	5.21	35	
Molybdenum	40.4	1.8	"	44.6	ND	87.7	75-125	4.83	35	
Nickel	85.4	2.7	"	44.6	43	95.1	75-125	4.35	35	
Selenium	37.0	8.9	"	44.6	ND	83.0	75-125	8.04	35	
Silver	3.29	0.62	"	4.46	ND	73.8	75-125	7.32	35	QM-07
Thallium	41.9	8.9	"	44.6	ND	89.2	75-125	7.13	35	
Vanadium	74.6	0.89	"	44.6	32	95.5	75-125	2.65	35	
Zinc	82.4	2.7	"	44.6	47	79.4	75-125	4.04	35	

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 08/22/01 14:16

Notes and Definitions

QM-07	The spike recovery was outside control limits for the MS and/or MSD. The batch was accepted based on acceptable LCS recovery.
QM-4X	The spike recovery was outside of control limits for the MS and/or MSD due to analyte concentration at 4 times or greater the spike concentration. The QC batch was accepted based on LCS and/or LCSD recoveries within the acceptance limits.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ATTACHMENT B-3.2

ANALYTICAL RESULTS OF TOTAL METALS IN SURFACE WATER COLLECTED NEAR SPILL SITE BY RWQCB ON SEPTEMBER 7, 2001

Sequoia Analytical

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14 September, 2001

Laurent Meillier
CRWQCB - San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

RE: Litigation Area Concord
Sequoia Report: P109107 RECREATE

Enclosed are the results of analyses for samples received by the laboratory on 09/10/01 14:00. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Mark Shipman
Project Manager

CA ELAP Certificate #2374

Sequoia Analytical

1455 McDowell Blvd, North Ste D
Petaluma, CA 94954
(707) 792-1865
FAX (707) 792-0342
www.sequoialabs.com

CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 09/14/01 11:15

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MEIL 002	P109107-01	Water	09/07/01 15:30	09/10/01 14:00
MEIL 003	P109107-02	Water	09/07/01 15:30	09/10/01 14:00

Sequoia Analytical - Petaluma

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Mark Shipman, Project Manager

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 09/14/01 11:15

Total Metals by EPA 6000/7000 Series Methods

Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MEIL 002 (P109107-01) Water Sampled: 09/07/01 15:30 Received: 09/10/01 14:00									
Aluminum	**3400**	200	ug/l	1	1090189	09/12/01	09/12/01	EPA 6010B	
Antimony	ND	60	"	"	"	"	"	"	
Arsenic	ND	100	"	"	"	"	"	"	
Barium	**120**	10	"	"	"	"	"	"	
Beryllium	ND	1.0	"	"	"	"	"	"	
Cadmium	ND	10	"	"	"	"	"	"	
Chromium	ND	10	"	"	"	"	"	"	
Cobalt	ND	7.0	"	"	"	"	"	"	
Copper	**13**	10	"	"	"	"	"	"	
Lead	ND	75	"	"	"	"	"	"	
Molybdenum	ND	20	"	"	"	"	"	"	
Nickel	ND	30	"	"	"	"	"	"	
Selenium	ND	100	"	"	"	"	"	"	
Silver	ND	7.0	"	"	"	"	"	"	
Thallium	ND	100	"	"	"	"	"	"	
Vanadium	**10**	10	"	"	"	"	"	"	
Zinc	**120**	20	"	"	"	"	"	"	
MEIL 003 (P109107-02) Water Sampled: 09/07/01 15:30 Received: 09/10/01 14:00									
Aluminum	**7100**	200	ug/l	1	1090189	09/12/01	09/12/01	EPA 6010B	
Antimony	ND	60	"	"	"	"	"	"	
Arsenic	ND	100	"	"	"	"	"	"	
Barium	**110**	10	"	"	"	"	"	"	
Beryllium	ND	1.0	"	"	"	"	"	"	
Cadmium	ND	10	"	"	"	"	"	"	
Chromium	ND	10	"	"	"	"	"	"	
Cobalt	ND	7.0	"	"	"	"	"	"	
Copper	**13**	10	"	"	"	"	"	"	
Lead	ND	75	"	"	"	"	"	"	
Molybdenum	ND	20	"	"	"	"	"	"	
Nickel	ND	30	"	"	"	"	"	"	
Selenium	ND	100	"	"	"	"	"	"	
Silver	ND	7.0	"	"	"	"	"	"	
Thallium	ND	100	"	"	"	"	"	"	
Vanadium	ND	10	"	"	"	"	"	"	
Zinc	**120**	20	"	"	"	"	"	"	

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 09/14/01 11:15

Total Metals by EPA 6000/7000 Series Methods - Quality Control

Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1090189 - EPA 3010A										
Blank (1090189-BLK1)				Prepared & Analyzed: 09/12/01						
Aluminum	ND	200	ug/l							
Antimony	ND	60	"							
Arsenic	ND	100	"							
Barium	ND	10	"							
Beryllium	ND	1.0	"							
Cadmium	ND	10	"							
Chromium	ND	10	"							
Cobalt	ND	7.0	"							
Copper	ND	10	"							
Lead	ND	75	"							
Molybdenum	ND	20	"							
Nickel	ND	30	"							
Selenium	ND	100	"							
Silver	ND	7.0	"							
Thallium	ND	100	"							
Vanadium	ND	10	"							
Zinc	ND	20	"							
LCS (1090189-BS1)				Prepared & Analyzed: 09/12/01						
Aluminum	6200	200	ug/l	6250		99.2	80-120			
Antimony	629	60	"	625		101	80-120			
Arsenic	647	100	"	625		104	80-120			
Barium	628	10	"	625		100	80-120			
Beryllium	63.9	1.0	"	62.5		102	80-120			
Cadmium	64.7	10	"	62.5		104	80-120			
Chromium	642	10	"	625		103	80-120			
Cobalt	634	7.0	"	625		101	80-120			
Copper	627	10	"	625		100	80-120			
Lead	646	75	"	625		103	80-120			
Molybdenum	637	20	"	625		102	80-120			
Nickel	658	30	"	625		105	80-120			
Selenium	628	100	"	625		100	80-120			
Silver	61.9	7.0	"	62.5		99.0	80-120			
Thallium	637	100	"	625		102	80-120			
Vanadium	638	10	"	625		102	80-120			
Zinc	635	20	"	625		102	80-120			

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 09/14/01 11:15

Total Metals by EPA 6000/7000 Series Methods - Quality Control

Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1090189 - EPA 3010A										
Matrix Spike (1090189-MS1)		**Source: P109107-01**		Prepared & Analyzed: 09/12/01						
Aluminum	10500	200	ug/l	6250	3400	114	75-125			
Antimony	607	60	"	625	ND	97.1	75-125			
Arsenic	631	100	"	625	ND	97.3	75-125			
Barium	647	10	"	625	120	84.3	75-125			
Beryllium	53.8	1.0	"	62.5	ND	85.3	75-125			
Cadmium	60.4	10	"	62.5	ND	96.6	75-125			
Chromium	566	10	"	625	ND	89.7	75-125			
Cobalt	542	7.0	"	625	ND	86.4	75-125			
Copper	588	10	"	625	13	92.0	75-125			
Lead	596	75	"	625	ND	95.4	75-125			
Molybdenum	565	20	"	625	ND	89.3	75-125			
Nickel	565	30	"	625	ND	88.2	75-125			
Selenium	584	100	"	625	ND	93.4	75-125			
Silver	57.5	7.0	"	62.5	ND	87.4	75-125			
Thallium	559	100	"	625	ND	85.9	75-125			
Vanadium	573	10	"	625	10	90.1	75-125			
Zinc	732	20	"	625	120	97.9	75-125			
Matrix Spike Dup (1090189-MSD1)		**Source: P109107-01**		Prepared & Analyzed: 09/12/01						
Aluminum	9920	200	ug/l	6250	3400	104	75-125	5.68	20	
Antimony	600	60	"	625	ND	96.0	75-125	1.16	20	
Arsenic	632	100	"	625	ND	97.4	75-125	0.158	20	
Barium	637	10	"	625	120	82.7	75-125	1.56	20	
Beryllium	53.4	1.0	"	62.5	ND	84.7	75-125	0.746	20	
Cadmium	61.2	10	"	62.5	ND	97.9	75-125	1.32	20	
Chromium	568	10	"	625	ND	90.0	75-125	0.353	20	
Cobalt	546	7.0	"	625	ND	87.0	75-125	0.735	20	
Copper	575	10	"	625	13	89.9	75-125	2.24	20	
Lead	584	75	"	625	ND	93.4	75-125	2.03	20	
Molybdenum	570	20	"	625	ND	90.1	75-125	0.881	20	
Nickel	563	30	"	625	ND	87.8	75-125	0.355	20	
Selenium	592	100	"	625	ND	94.7	75-125	1.36	20	
Silver	59.4	7.0	"	62.5	ND	90.4	75-125	3.25	20	
Thallium	556	100	"	625	ND	85.4	75-125	0.538	20	
Vanadium	572	10	"	625	10	89.9	75-125	0.175	20	
Zinc	759	20	"	625	120	102	75-125	3.62	20	

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CRWQCB - San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland CA, 94612	Project: Litigation Area Concord Project Number: N/A Project Manager: Laurent Meillier	**Reported:** 09/14/01 11:15

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

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SEQUOIA ANALYTICAL CHAIN OF CUSTODY

❑ 885 Jarvis Drive • Morgan Hill, CA 95037 • (408) 776-9600 • FAX (408) 782-6308
❑ 819 Striker Ave., Suite 8 • Sacramento, CA 95834 • (916) 921-9600 FAX (916) 921-0100
❑ 404 N. Wiget Lane • Walnut Creek, CA 94598 • (925) 988-9600 FAX (925) 988-9673
❑ 1455 McDowell Blvd. North, Suite D • Petaluma, CA 94954 • (707) 792-1865 FAX (707) 792-0342
❑ 1551 Industrial Road • San Carlos, CA 94070 • (650) 232-9600 FAX (650) 232-9612

Company Name: RWQCB (San Francisco Bay)	Project Name: Litigation Area Concord
Mailing Address: 1515 Clay St #1400	Billing Address (if different):
City: OAKLAND State: CA Zip Code: 94612	
Telephone: 510-622-2440 FAX #:	P.O. #:
Report To: MEILLIER Sampler: MEILLIER	QC Data: ❑ Level D (Standard) ❑ Level C ❑ Level B ❑ Level A

Turnaround Time: ❑ 10 Working Days ❑ 3 Working Days ❑ 2 - 8 Hours ❑ 7 Working Days ❑ 2 Working Days ✓ 5 Working Days ❑ 24 Hours

❑ Drinking Water ❑ Waste Water ✓ Other

Analyses Requested: METALS (ALL)

Client Sample I.D.	Date/Time Sampled	Matrix Desc.	# of Cont.	Cont. Type	Sequoia's Sample #	METALS (ALL)	Comments
1. MEIL002	9/7/01 3:30pm	H_2O	1	500mL	P1091070 1	✓	Analyze for metals
2. MEIL003	9/7/01 3:30pm	H_2O	1	500mL	2	✓	Analyze for metals
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

COOLER CUSTODY SEALS INTACT ☐
NOT INTACT ☐
COOLER TEMPERATURE 2.4 °C

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
			Alorenzo	9/10/01	1300 at lab 1400
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

Were Samples Received in Good Condition? ❑ Yes ❑ No Samples on Ice? ❑ Yes ❑ No Method of Shipment_____ Page ___ of ___

Pink - Client
Yellow - Sequoia
White - Sequoia

APPENDIX B-4

PHOTOGRAPHS FROM FOLLOW-UP SITE VISIT BY TETRA TECH EM INC., SEPTEMBER 5, 2001

On September 5, 2001, Mary Gleason and Cindi Rose, Tetra Tech EM Inc (TtEMI), visited the Litigation Area to observe the areas of concern identified during the site inspection tour on July 27, 2001. They took photographs of the area of distressed vegetation in remedial action subsite (RASS 1) and the railcar spill area between RASSs 2 and 3. While at the site, they observed that plastic covering the stockpile of contaminated soil at the Chemical and Pigment Company (CPC) site had been torn. They also observed that a large portion of RASS 4 had burned. They reported their observations to the Navy the following day. The photographs and captions below document those observations.

Photograph No. 1. Area of Distressed Vegetation in Remediated Area of RASS 1. This area is located along the edge of the berm separating Navy property from the General Chemical Company (GCC)/Honeywell, Inc. waste lagoons. View looking north toward Suisun Bay. The area was measured, mapped, and marked on November 16, 2001 (see Appendix B-4).

Photograph No. 2. Area of Distressed Vegetation in RASS 1. View looking south toward Los Medanos Hills. Berm separating GCC facility from Navy property is on the left.

Photograph No. 3. Area of Distressed Vegetation in RASS 1. The size of dead or distressed vegetation or bare area is about 160 feet long by 10 to 20 feet wide.

Photograph No. 4. White Powder Spilling from Parked Railcar on Side Spur Leading to GCC facility. Side spur is located between RASSs 2 and 3. This spill is similar to a spill observed during the site inspection tour on July 27, 2001, indicating that the problem has not been resolved.

Photograph No. 5. Evidence of Past Spills Along Railroad Spur Leading to GCC Facility.

Photograph No. 6. Spilled Chemical Powder Along Railroad Tracks Leading to GCC Facility. View looking east toward GCC from the rail spur between RASSs 2 and 3.

Photograph No. 7. Spilled Chemical Blown into Vegetation Bordering Wetland Ditches and Slough in RASS 1.

Photograph No. 8. Torn Plastic Covering over Stockpile of Contaminated Soil at the CPC Facility. Contaminated soil is exposed to wind and rain.

Photograph No. 9. Closer View of Uncovered Stockpile of Contaminated Soil at CPC. Nichols Creek and Navy property lie just beyond the grove of eucalyptus trees.

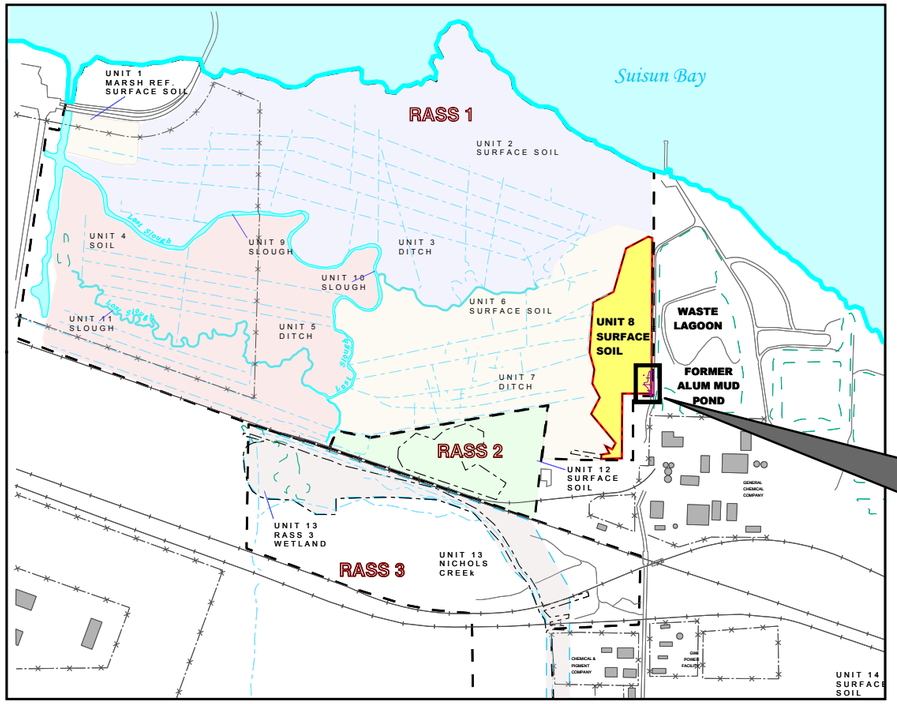
Photograph No. 10. View of RASS 4 from Port Chicago Highway. Wildfires in August 2001 burned about half of the site, including areas that had been remediated and revegetated with native grasses and coyote bushes.

Photograph No. 11. View of RASS 4 from Port Chicago Highway.

Photograph No. 12. View of RASS 4 Burned Area from Port Chicago Highway.

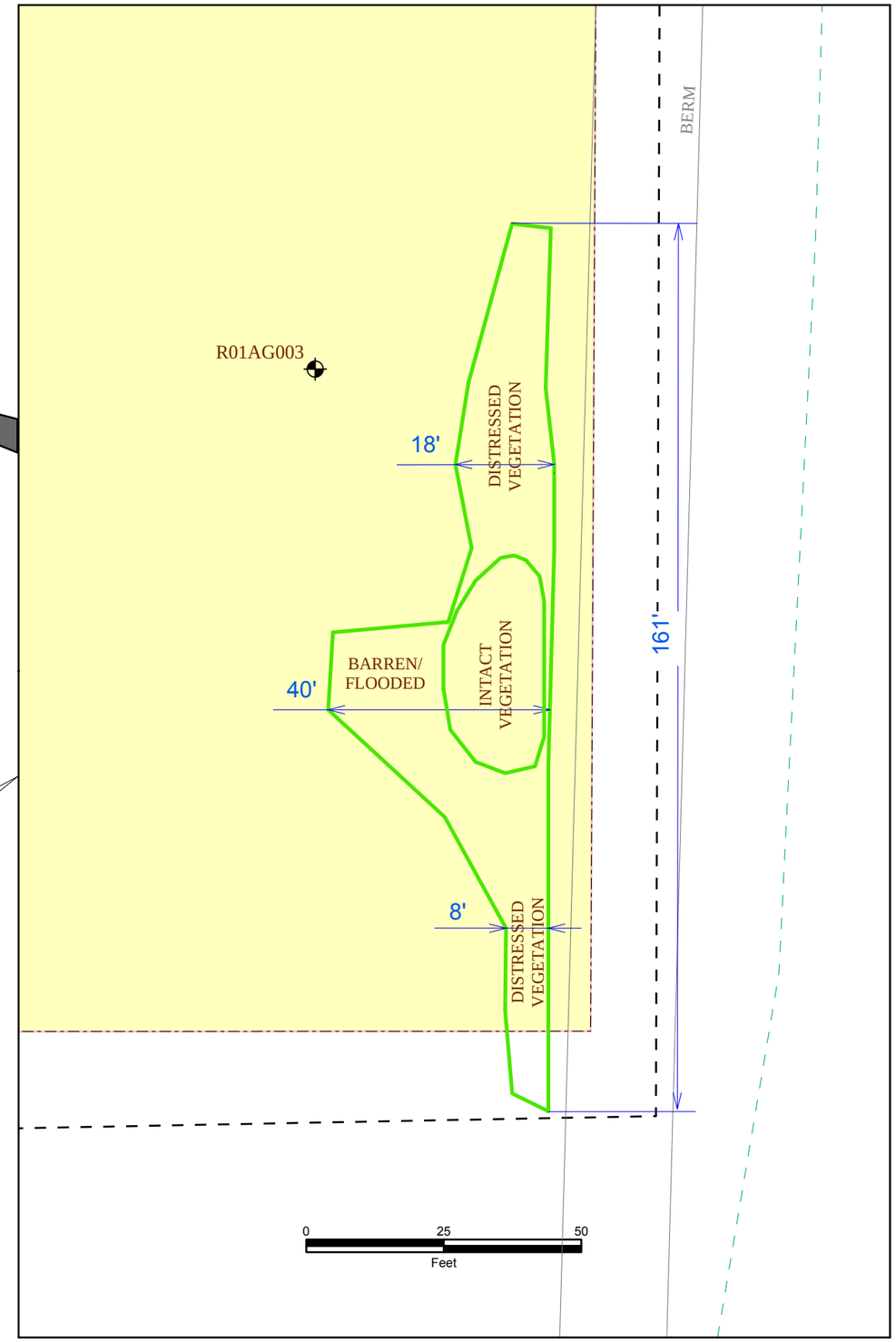
APPENDIX B-5

AREA OF DISTRESSED VEGETATION IN RASS 1 ACTIVE REMEDIATION AREA, NOVEMBER 16, 2001



CLOSE-UP OF AREA OF DISTRESSED VEGETATION

PHOTO TAKEN ON SEPTEMBER 3, 2001. VIEW LOOKING TOWARD SUISUN BAY (NORTH), WITH GENERAL CHEMICAL BERM ON THE RIGHT



NOTE:
THE LOCATION AND SIZE OF THE AREA OF DISTRESSED VEGETATION WAS MAPPED, MEASURED, AND MARKED WITH SURVEY STAKES ON NOVEMBER 16, 2001

Tetra Tech EM Inc.

LITIGATION AREA
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

APPENDIX B-5
AREA OF DISTRESSED VEGETATION IN RASS 1 ACTIVE REMEDIATION AREA
NOVEMBER 16, 2001

04-19-2002 V:\Concord\Projects\Unit8_Distressed_Vegetation\unit8_distressed_vegetation.mxd TtEMI-SF Alex Zhuk

APPENDIX C

COMMUNITY SUMMARY REPORT
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

(21 Pages)

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order No. 373

Prepared For

DEPARTMENT OF THE NAVY
Gilbert Rivera, Remedial Project Manager
Engineering Field Activity West
Naval Facilities Engineering Command
Daly City, California

DRAFT FINAL COMMUNITY SUMMARY REPORT FIVE-YEAR PERIODIC REVIEW ASSESSMENT LITIGATION AREA NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

TC.0373.11493

OCTOBER 23, 2002

Prepared By

TETRA TECH EM INC.
135 Main Street, Suite 1800
San Francisco, California 94105
(415) 543-4880

Mary Gleason, Ph.D., Project Manager

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TABLE

Table

C-1 SITE CHRONOLOGY FOR THE LITIGATION AREA

ACRONYMS AND ABBREVIATIONS

BERA	Baseline ecological risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPC	Chemical Pigment Company
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
GCC	General Chemical Company
HHRA	Human health risk assessment
HI	Hazard index
Navy	U.S. Department of the Navy
PCB	Polychlorinated biphenyl
RAB	Restoration Advisory Board
RAP	Remedial action plan
RASS	Remedial action subsite
ROD	Record of decision
RWQCB	California Regional Water Quality Control Board
SARAC	Statistically above reference area criteria
SBD	Seal Beach Detachment
TtEMI	Tetra Tech EM Inc.

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy) evaluated the effectiveness of completed environmental cleanup and restoration actions at the Litigation Area sites in the Tidal Area at Naval Weapons Station Seal Beach Detachment (SBD) Concord. The five-year review process is required under the Comprehensive Environmental Response, Compensation, and Liability Act at sites where (1) contaminants are left in place and (2) the record of decision (ROD) was signed after October 1986. The review was conducted in a manner consistent with U.S. Environmental Protection Agency (EPA) guidance (EPA 2001).

The goals of the post-cleanup five-year review were as follows:

- Determine whether the selected remedies (actions) were protective of human health and the environment
- Determine whether additional cleanup actions are necessary

The specific objectives of the five-year review assessment were as follows:

- Determine whether the remedy is functioning as intended under the ROD
- Determine whether the assumptions made at the time of the remedy are still valid
- Determine whether any other information calls into question whether the remedy is protective of human health and the environment

The Navy notified the public of the review process through a newspaper advertisement in the October 18, 2001, *Contra Costa Times*. The results of the five-year review are presented in the two-volume draft final five-year periodic review assessment report (dated October 23, 2002), which can be found in the information repository at the Concord Branch Library on Salvio Street in Concord, California. The information repository also contains other background documents and information about the site. The Navy provided a draft community summary report to the Restoration Advisory Board (RAB) on February 19, 2002, and presented the results of the five-year review to the RAB on April 22, 2002. The Navy welcomes public input on the draft final five-year periodic review assessment report or this community summary.

2.0 BACKGROUND

The Litigation Area sites are located near the intersection of Nichols Road and Port Chicago Highway near the eastern boundary of the Tidal Area (Figure C-1). This property was acquired by the Navy in the

1970s from several different property owners and was subsequently found to be contaminated with metals (arsenic, cadmium, copper, lead, selenium, and zinc) resulting from waste disposal activities and historic spills originating from neighboring chemical companies. The Navy did not conduct any activities on these sites that contributed contamination.

Four sites within the Litigation Area, known as remedial action subsites (RASS), were identified for cleanup (remediation) in a remedial investigation and feasibility study completed in 1988 (Figure C-2). Six metals were identified as chemicals of concern: arsenic, cadmium, copper, lead, selenium, and zinc. On April 6, 1989, the Navy issued a final remedial action plan (RAP) and signed a ROD documenting the cleanup decisions.

The cleanup (remediation) involved removal and disposal of contaminated soil and was conducted between 1992 and 1995. The Navy restored the cleaned up areas (or remediated areas) by planting native plants in 1996. Because the Litigation Area includes wetlands that provide habitat for several threatened or endangered species, some contaminated soil was left in place to avoid destroying sensitive habitat. As documented in the ROD, the Navy agreed to monitor the site after the cleanup actions to ensure that the selected remedy was effective. The Navy implemented a monitoring plan as part of its environmental program to assess contaminant migration and ecological effects of the contaminants left in place. The Navy completed 5 years of post-cleanup monitoring before initiating the five-year review assessment.

The following table provides an overview of the five-year review:

Litigation Area, Naval Weapons Station SBD Concord	
Lead Agency	Naval Facilities Engineering Command, Engineering Field Activity West Gilbert Rivera, Remedial Project Manager
Supporting Organizations	Tetra Tech EM Inc. (TtEMI) and Uribe and Associates – contractors to the Navy
Review Number	First Review
Review Type	Statutory (required by law)
Trigger Action and Date	Remedial action construction and revegetation completed at all sites in June 1996
Operable Units	RASSs 1 through 4
Implementation Status	Construction complete: remedial actions and revegetation completed for all four RASSs; 5 years of post-cleanup monitoring completed.

Compliance with the ROD and protectiveness of the remedy were evaluated during the five-year review. The Navy conducted a screening-level human health risk assessment (HHRA) and a baseline ecological risk assessment (BERA) to evaluate whether metals contamination left at the site presents an ongoing risk. The Navy worked closely with the following federal and state agencies to determine the approach and scope of the five- year review:

- U.S. Environmental Protection Agency (EPA)
- U.S. Fish and Wildlife Service
- National Oceanic and Atmospheric Administration (NOAA)
- California Department of Toxic Substances Control (DTSC)
- California Regional Water Quality Control Board (RWQCB)
- California Department of Fish and Game

3.0 RESULTS OF THE FIVE-YEAR REVIEW

The following sections briefly summarize major results of the five-year review.

3.1 REVIEW OF SITE DOCUMENTS

Documents used to support decisions about the cleanup and monitoring program were reviewed to summarize past investigations, identify assumptions and rationale for prior decisions, and provide a complete timeline for the site; a chronology for the site is provided as Table C-1. The Navy reviewed documents that formed the basis for selecting the environmental cleanup action (remedy); documents related to the design, implementation, and maintenance of the remedy; supporting legal documents; and correspondence.

The full extent of contamination in RASS 1 may not have been known at the time the remedy was selected and the ROD was signed; early sampling before the ROD focused on the eastern portion of RASS 1, and, after the signing of the ROD, contamination was found in the western part of RASS 1. The nature and extent of contamination was, however, well characterized during post-cleanup monitoring. The same six metals identified during the remedial investigation (arsenic, cadmium, copper, lead, selenium, and zinc) are still considered to be the chemicals of concern at the site.

The Navy's cleanup actions were selected and implemented in a manner consistent with the National Oil and Hazardous Substances Pollution Contingency Plan. The Navy established the following four specific objectives for the cleanup action:

1. Prevent plants and animals from contacting contaminated soils that would threaten them.
2. Prevent resuspension of contaminated sediments and soils in surface water and air and redistribution of contaminated sediments and soils, which would threaten plants and animals in the area.
3. Minimize disturbance to the wetlands consistent with long-term protection of plants and animals.
4. Prevent migration of contaminants into groundwater.

The Navy selected soil cleanup goals based on hazardous waste criteria; these included total threshold limit concentration, soluble threshold limit concentration, and statistically above reference area criteria (SARAC) values. To protect wetland habitat and special status species from the habitat destruction associated with cleanup, these criteria were waived in some contaminated portions of the wetland in RASSs 1 and 2 and some contamination above these levels was left in place. The RAP and ROD identified the potential for additional cleanup actions in these areas, if needed.

3.2 REVIEW OF LEGAL REQUIREMENTS AND OTHER GUIDANCE

The Navy reviewed environmental standards identified before the cleanup as well as more recent federal and state standards and guidance that address the protectiveness of environmental cleanups. The Navy acknowledges that current guidelines support the use of risk assessment to help make decisions on cleanup goals for the protection of human health and the environment. Considering the refinement of risk assessment methodology and guidance since the remedy was selected in 1989, the Navy agreed to conduct a screening-level HHRA and a BERA as part of the five-year review. These risk assessments were used to evaluate whether contaminants at the site pose an unacceptable risk to humans or plants and animals; results of those assessments are discussed later in this document.

Cleanup criteria were met in areas actively cleaned up by the Navy. However, these criteria were not met in portions of the wetland in RASSs 1 and 2 where the criteria were waived and no cleanup was conducted because of concerns about habitat destruction and special status species. Currently, concentrations of metals are still above cleanup criteria in some portions of the site that were not cleaned up.

The Navy worked closely with the RWQCB and EPA to identify new Clean Water Act standards appropriate for the site including beneficial use designations in "The Basin Plan"(RWQCB 1995) for the San Francisco Bay Basin, published by the RWQCB, and EPA ambient water quality criteria.

In accordance with federal and state Endangered Species Acts, three animal species with special status were considered during selection and implementation of the remedy: the salt marsh harvest mouse (*Reithrodontomys raviventris*), the California Clapper Rail (*Rallus longirostris obsoletus*), and the California Least Tern (*Sterna antillarum*). Based on more recent site-specific wildlife surveys, the clapper rail and the least tern are not considered by the Navy to inhabit the site. Since other threatened or endangered species have been observed at the site or have been given special status since 1989, the protectiveness of the remedy was evaluated in light of this new information.

3.3 SITE INSPECTION TOUR

On July 27, 2001, the Navy led a site inspection tour of the Litigation Area. Notes and photographs taken during the inspection tour are included in Appendix B of the draft final five-year periodic review assessment report (dated April 30, 2002). Participants included representatives of the Navy, federal and state regulatory and trustee agencies, and contractors. The tour focused on those portions of the Litigation Area that pose some concern. The group observed the following:

- Near RASS 2, a parked railcar leaking white powder on a rail spur leading to the General Chemical Company (GCC) facility
- An area of distressed and dead wetland vegetation in RASS 1 along the berm separating Navy property from the GCC facility
- Motorcycle tracks and an open gate in RASS 4, indicating that trespassers had gained access to the site and Navy access controls were inadequate
- Semilithified (ashy) soil in RASS 4

RWQCB staff subsequently reported the railcar spill near RASS 2 to Mr. Curtis Scott, the RWQCB Division Chief. A sample of the powder was analyzed; results of analysis indicated the powder contained aluminum (13%), and lesser amounts of zinc and beryllium.

In August 2001, several arson-related brush fires burned approximately one-third of RASS 4. On a subsequent site visit in September 2001, TtEMI took photographs of the burned area in RASS 4. TtEMI also observed that plastic sheeting covering a stockpile of contaminated soil at the Chemical Pigment Company (CPC) facility on Nichols Road next to Navy property was ripped, exposing the soil to weather.

On June 10, 2002, the Navy led a tour of the site for RAB members.

3.4 REVIEW OF MONITORING PROGRAM RESULTS

The Navy conducted chemical and ecological monitoring before, during, and after the cleanup activities to document the effectiveness of the remedy. The monitoring program included chemical analysis (soil, sediment, and surface water), ecological surveys (vegetation, small mammals, and rails), and evaluation of the success of the restoration efforts in cleaned up areas. The extensive data collected as part of the monitoring program were summarized and evaluated to assess changes at the site. The monitoring objectives and the effectiveness of the monitoring program were also evaluated during the five-year review to make recommendations about future monitoring at the site.

There was little indication of significant changes in metals concentrations in portions of the site that were not cleaned up. In addition, based on the monitoring data, cleaned up areas in RASSs 1, 2, and 4 are not becoming recontaminated by contaminants remaining in other parts of the site. Erosion of contaminated soils along Nichols Creek and ongoing upgradient sources at off-site neighboring chemical companies may still be contaminating portions of RASS 3 and RASS 1, including cleaned up areas.

Ecological surveys indicated the continued presence and use of the site by special status plants and animals; most populations of special status species were stable or increased over the 5 years of post-cleanup monitoring. Results indicated that the revegetation efforts were very successful in most of the cleaned up areas; some special status plant and animal species have recolonized the cleaned up area restored to wetland habitat in RASS 1.

3.5 EVALUATION OF EXISTING SOURCES AND MIGRATION OF CONTAMINANTS

The potential for ongoing, off-site (non-Navy) sources of contamination to the Litigation Area was evaluated through a file review of current environmental investigations at neighboring facilities and observations at the site. DTSC has documented that high concentrations of contaminants remain at the abandoned CPC facility and the operating GCC facility. In addition, DTSC has stated that a high potential exists for off-site migration from the CPC facility. Since the Navy's property is downgradient from CPC, a high potential exists that migration of metals from CPC may still be affecting the Litigation Area.

Migration of contaminants in soil, sediment, surface water, and groundwater within the site was evaluated using data from the monitoring program and from special studies. Areas of contaminated soil are actively

eroding along Nichols Creek in RASS 3, and the upgradient CPC facility may be contributing contaminated surface runoff and groundwater to Nichols Creek. The areas of most extensive soil erosion along Nichols Creek are on railroad property.

Contaminants on the marsh surface in RASSs 1 and 2 are being buried by cleaner sediment through the natural process of marsh accretion; the highest metal concentrations were detected at 3 to 5 inches below ground surface. The dense vegetation on the marsh surface and vertical profiles of contamination indicate that little migration of contaminants from the marsh surface is occurring.

Uncontrolled migration of contaminants in sediments in the mosquito ditches and tidal slough may occur in the southern part of RASS 1 since vertical profiles of contaminants indicate areas of sediment erosion and accumulation. Tidal water quality sampling does not indicate that the site is exporting significant amounts of contaminants in surface water to Suisun Bay or that contaminated sediments are migrating all the way out of Lost Slough to the bay.

Groundwater discharge of contaminants to surface water is likely to be very limited in the marsh because of low flow rates through fine-grained sediments. As a result, groundwater contamination does not appear to pose a major problem in the Litigation Area marsh; however, high concentrations of metals in groundwater at the neighboring, upgradient CPC facility in the upland habitat may be migrating into Nichols Creek in RASS 3. In addition, contaminated groundwater from the General Chemical/Honeywell facility adjacent to RASS 1 may be a continuing source of contaminants to the wetland; an area of distressed vegetation was observed on the border of the Navy and chemical company properties in an area that the Navy had cleaned up.

3.6 SCREENING-LEVEL HUMAN HEALTH RISK ASSESSMENT

The Navy conducted a screening-level human health risk assessment (HHRA) to evaluate risks to human health from contaminants left at the site. A two-tiered screening-level HHRA was conducted. The first tier evaluated the site using a scenario of future residential and commercial land use; this scenario is very unlikely and was evaluated only as a point of reference. The second tier used a more realistic scenario of occasional access to the site by workers, such as a mosquito abatement worker. The site is currently used as a buffer zone, and access is limited to occasional entry by Navy personnel and approved workers.

Under the assumption that land use changes in the future, estimated cancer risks and noncancer hazard indices (HI) for a resident and a commercial/industrial worker exceed risk management levels considered protective of human health in some areas of RASSs 1 through 4.

Under the assumption that current land-use and site conditions remain unchanged, estimated cancer risks and noncancer HIs for current receptors, as represented by the mosquito abatement worker, are within or less than risk management levels. These risk findings indicate that current environmental conditions at the Litigation Area do not pose an unacceptable risk to human health based on the continued use of this area as a buffer zone with restricted access. Recent evidence of trespass in RASS 4 indicates that current access controls are inadequate and should be improved.

3.7 BASELINE ECOLOGICAL RISK ASSESSMENT

The Navy conducted a baseline ecological risk assessment to evaluate risk to plants and animals from contaminants left at the site. This assessment focused on potential threats to plants, aquatic invertebrates and fish, as well as birds and mammals that inhabit the site.

Concentrations of metals in soil and sediment at selected areas of the site may pose some unacceptable risk to individual plants for some species; however, unacceptable risk is not indicated at the population level for wetland or upland plant species at the Litigation Area. There was no indication of unacceptable risk to special status plants across the site.

Elevated concentrations of metals in sediment and surface water may pose some unacceptable risk to populations of fish and aquatic invertebrates at selected locations in the southern reaches of the tidal slough in RASS 1. The unacceptable risk is determined on the basis of some observed toxicity in laboratory toxicity tests, accumulation of metals in tissues of fish and invertebrates collected at the site, and comparison of chemical concentrations with available toxicity-based benchmarks.

Risk to birds and mammals was evaluated using a food-chain model that assesses the potential dose of contaminants an animal could receive during normal feeding and grooming behavior at the site. Some unacceptable risk from exposure to metals may exist for populations of the California Black Rail (*Laterallus jamaicensis coturniculus*) (primarily from zinc) and the Suisun Song Sparrow (*Melospiza melodia maxillaris*) (primarily from selenium) along areas of the main tidal slough in RASS 1 and in the mosquito ditches in the southeastern portion of RASS 1. Some unacceptable risk from arsenic was indicated for individual salt marsh harvest mice at a small number of locations in the marsh in the southeastern portion of RASS 1; however, population-level effects were not indicated for harvest mice at any areas of the site.

The ecological risk assessment concluded that metals contamination poses some unacceptable risk to invertebrates, fish, California Black Rails, and Song Sparrows in the southern part of RASS 1.

4.0 CONCLUSIONS AND RECOMMENDATIONS OF THE FIVE-YEAR REVIEW

The draft final five-year review identified problems or deficiencies with the cleanup, identified data gaps, explained whether environmental conditions at the site are currently protective of human health and the environment, and made risk management recommendations. The Navy discussed the site with the regulatory and other trustee agencies at risk management meetings on February 22 and March 27, 2002, and identified specific actions to address areas of concern and data gaps.

Given the evidence suggesting ongoing off-site sources of contaminants to the Litigation Area, the Navy doubts its ability to protect human health and the environment or to provide long-term protection for the site. The Navy proposes to address upgradient sources and areas before addressing downgradient areas that are not protective. The Navy will work with state and federal agencies and, if necessary, the Department of Justice to resolve issues with neighboring property owners. Because concerns still exist at the site, the Navy proposes to (1) collect additional data in focused studies to address data gaps and (2) at some time in the future when off-site sources have been addressed, conduct supplemental feasibility studies to address portions of the site that are not protective. The Navy will also conduct limited monitoring of site conditions at five-year intervals. In addition, the Navy made general recommendations in the draft final five-year review for creating more focused future monitoring objectives and clearly identifying how future monitoring will trigger additional actions.

Section 4.1 describes the data gaps and the proposed plans for collecting additional data. Section 4.2 presents the protectiveness statements, deficiencies of the remedy, and the Navy's proposed plans to address deficiencies for each RASS.

4.1 DATA GAPS AND PROPOSED PLANS FOR COLLECTION OF ADDITIONAL DATA

The Navy identified data gaps based on a review of existing data and observations made during the site inspection tour during the five-year review. The Navy proposes to conduct additional investigations to further evaluate ongoing off-site sources and to resolve any on-site data gaps before addressing concerns about protectiveness of the remedy within the Litigation Area. The data gaps identified and the Navy's proposed plan for collecting additional data are as follows:

- **Distressed Vegetation in RASS 1:** Distressed and dead vegetation observed in the cleaned-up portion of RASS 1 along the border of Navy property could be related to contaminant migration from neighboring chemical facilities. A preliminary file review documented high concentrations of metals and acidity in groundwater at the General Chemical facility. The Navy proposes (1) soil and groundwater sampling in the area of distressed vegetation in RASS 1 and (2) conducting a file review of neighboring companies to determine whether chemical contamination is causing the observed impacts to vegetation.

- **Groundwater-Surface Water Interactions at the CPC Border:** A preliminary file review documented extremely high concentrations of metals in groundwater at CPC. The extent of groundwater-surface water interaction at the border of CPC and Nichols Creek on Navy property is not known; however, concern exists due to the potential for contaminated groundwater to migrate from CPC to the Navy's property. The Navy proposes (1) establishing and sampling new wells on the border of the CPC property and (2) evaluating groundwater-surface water interactions and the potential for contaminant migration into Nichols Creek.

- **Litigation Area Groundwater Well Sampling:** Groundwater wells at the Litigation Area have not been sampled since 1996, when groundwater monitoring was terminated during Year 2 of the annual monitoring program. Nineteen quarters of groundwater sampling had been conducted by 1996; groundwater was considered to be adequately characterized at that time. In addition, metals concentrations had declined after cleanup of contaminated soils. The Navy proposes sampling all existing groundwater wells at the Litigation Area for metals to evaluate current groundwater quality.

- **RASS 3 Polychlorinated Biphenyl (PCB) Sampling:** PCBs were generally not detected and posed no ecological or human health risk. However, a small area in RASS 3 adjacent to the railroad tracks and along Nichols Creek has not been adequately characterized for PCBs. The Navy proposes PCB sampling along the railroad track and Nichols Creek in RASS 3 to better characterize the spatial distribution of PCBs in the area.

- **RASS 4 Soils:** Semilithified or ashy soil was observed in RASS 4 during the site inspection tour in July 2001. The chemical composition of this soil material is not known. The Navy proposes soil sampling in RASS 4 to determine the chemical composition of the semilithified soil.

4.2 PROTECTIVENESS STATEMENTS, DEFICIENCIES, AND RECOMMENDATIONS FOR EACH RASS

Based on EPA guidance, cleanup actions were not considered protective if (1) an immediate threat is present or (2) migration of contaminants is uncontrolled (EPA 2001). Each RASS was evaluated separately to determine protectiveness of the remedy. Factors that prevent cleanup actions from being protective of human health and the environment or have the potential to do so in the future were identified as deficiencies of the remedy.

No risk is posed to human health at the Litigation Area under current land use and environmental conditions. However, the presence of trespassers in RASS 4 indicates that access controls are currently inadequate at that portion of the site.

Remaining contamination in some areas of the site poses unacceptable risk to plants and animals. Unacceptable ecological risk and contaminant migration were identified as deficiencies of the remedy that affect protectiveness in RASSs 1 and 3.

The following sections discuss protectiveness of the remedy, deficiencies of the remedy, and the Navy's proposed plan for ensuring protectiveness of human health and the environment at each RASS.

4.2.1 RASS 1

Protectiveness of the Remedy: The remedy at RASS 1 is protective of human health. The remedy is not protective of the environment because uncontrolled migration of contaminants exists in the ditches and sloughs in the southern portion of RASS 1 and some risk exists to fish, invertebrates, and California Black Rails from contaminants remaining in these areas. In addition, the presence of distressed vegetation in the cleaned up area of RASS 1, adjacent to the neighboring chemical companies, is of concern.

Deficiencies of the Remedy: The following factors affect the protectiveness of the remedy at RASS 1:

- **Presence of ongoing off-site sources:** Neighboring properties may be ongoing sources of contaminants to the wetland in RASS 1. The GCC and Honeywell, Inc. properties to the east of RASS 1 may be an ongoing source of contaminants through groundwater migration or surface water runoff. In addition, railcar spills of aluminum-based powder on the railroad spur leading into the GCC facility have impacted water quality in the sloughs and ditches in RASS 1. The potentially responsible parties should address these off-site sources to ensure protectiveness of the remedy.

- **Uncontrolled migration and ecological risk in selected ditches and sloughs in southern RASS 1:** High concentrations of metals in sediments and uncontrolled migration of those sediments in ditches and sloughs in the southern portion of RASS 1 may pose a risk to plants and animals in the wetland. Therefore, metals in sediments in some of the ditches and sloughs in RASS 1 (Units 7, 10, and 11) remain a significant on-site source that poses some risk to fish, invertebrates and the California Black Rail.

Proposed Actions to Ensure Protectiveness: The Navy proposes the following actions to address areas of outstanding concern in RASS 1:

- Conduct a supplemental feasibility study focused on the mosquito ditches in Unit 7 of RASS 1 to address uncontrolled migration of contaminants and to evaluate remedial alternatives

- Conduct a supplemental feasibility study focused on the western arm of Lost Slough (Unit 11) in RASS 1 to address ecological risk and uncontrolled migration of contaminants and to evaluate remedial alternatives

These supplemental feasibility studies will be conducted only when the Navy has determined that significant off-site sources of contamination have been addressed to ensure that Navy property will not be recontaminated.

4.2.2 RASS 2

The remedy at RASS 2 is protective of human health and the environment, no deficiencies were identified for RASS 2, and no additional actions are proposed.

4.2.3 RASS 3

Protectiveness of the Remedy: The remedy at RASS 3 is protective of human health. The remedy is not protective of the environment because uncontrolled migration of contaminants still occurs in Nichols Creek, and risk remains to ecological receptors from contaminants that migrate from RASS 3 to the RASS 1 wetland.

Deficiencies of the Remedy: The following factors affect the protectiveness of the remedy at RASS 3:

- **Presence of ongoing off-site sources:** Neighboring properties may be ongoing sources of contaminants to RASS 3. The CPC facility, with its exposed stockpile of contaminated soil and high levels of metals in groundwater is upgradient from the Navy's property in RASS 3. DTSC has identified off-site migration of contaminants from CPC as a concern. The potentially responsible parties should address this off-site source to ensure protectiveness of the remedy.

- **Uncontrolled soil erosion in RASS 3:** Metals detected at high concentrations in soil or sediment at some locations in RASS 3 remain a potential on-site source to the wetland in RASS 1. Uncontrolled migration as a result of soil erosion along Nichols Creek in RASS 3 may mobilize and spread contaminants into the wetland habitat in RASS 1; however, two major erosional areas are on railroad property and are not the responsibility of the Navy.

Proposed Actions to Ensure Protectiveness: The Navy proposes conducting a supplemental feasibility study focused on erosional areas along Nichols Creek in RASS 3 to address uncontrolled soil erosion and to evaluate remedial alternatives to address areas of concern in RASS 3. The supplemental feasibility

study will be conducted only when the Navy has determined that significant off-site sources of contamination have been addressed to ensure that Navy property will not be recontaminated.

4.2.4 RASS 4

Protectiveness of the Remedy: The remedy at RASS 4 is protective of human health and the environment. Access controls must be improved to prevent trespass.

Deficiencies of the Remedy: Observations made during the site inspection tour in July 2001 indicate that trespassers have gained access to RASS 4. Access controls for RASS 4 were determined to be inadequate to prevent trespass by unauthorized persons. The site is not fenced on the north side, locks on the gates have been broken open, and evidence of motorcycle tracks and refuse dumping exists.

Proposed Actions to Ensure Protectiveness: The Navy proposes fencing the entire perimeter of RASS 4, conducting more regular security patrols, and posting signs warning of environmental hazards to prevent trespass.

5.0 CONTACT INFORMATION

For more information, please contact Mr. Gilbert Rivera, Navy Remedial Project Manager, at Engineering Field Activity West in Daly City, California, at (650) 746-7451.

6.0 REFERENCES

California Regional Water Quality Control Board (RWQCB). 1995. "San Francisco Bay Basin Water Quality Control Plan." June 21.

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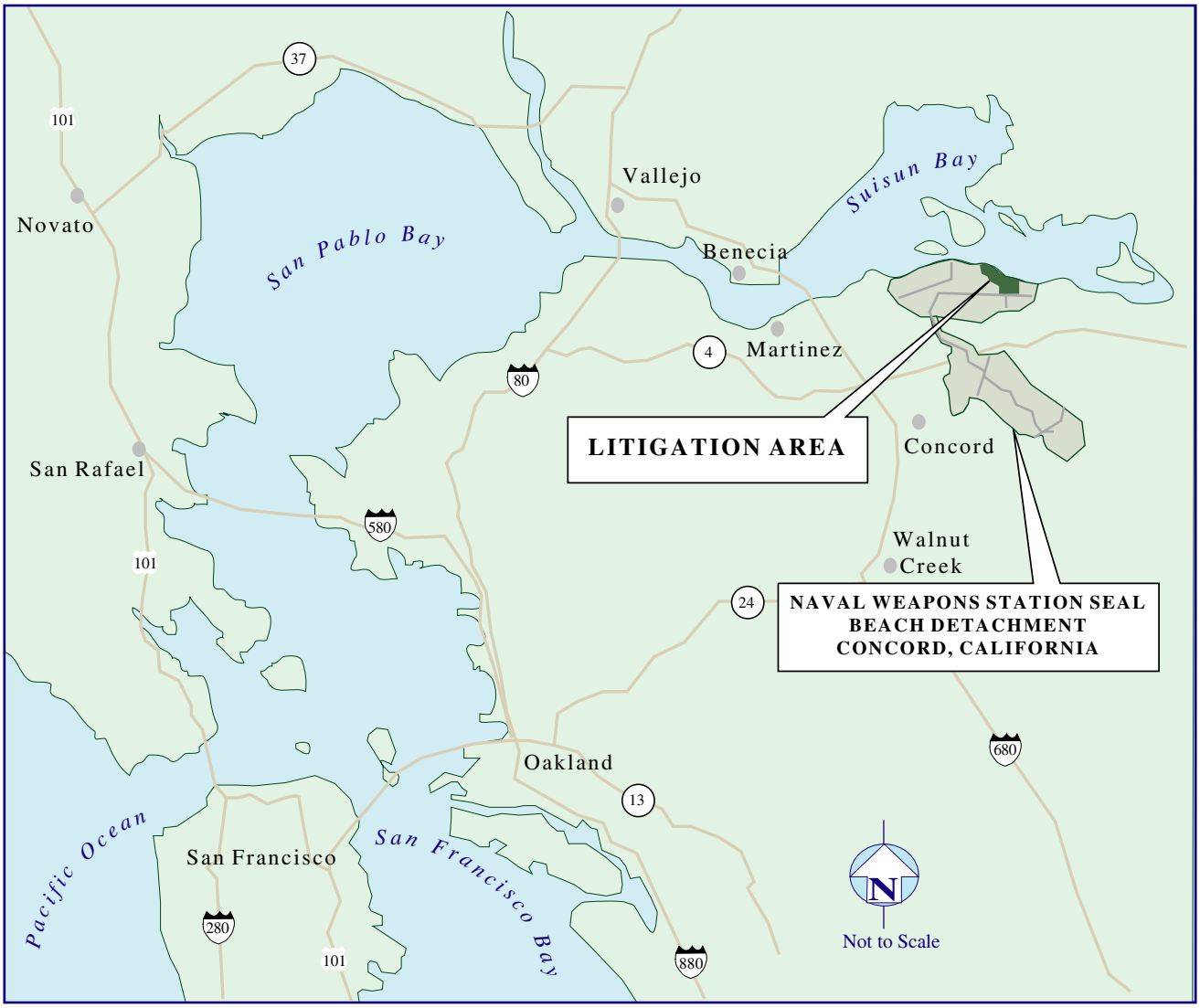

NWSSB DETACHMENT CONCORD
LITIGATION AREA

FIGURE C-1
SITE VICINITY MAP

TETRA TECH EM INC.

TC.0373.11493

Figure C-2

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

TABLE C-1

SITE CHRONOLOGY FOR THE LITIGATION AREA
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Event	Date
Initial discovery of contamination; Department of Health Services notified Navy of the release from neighboring properties	August 1980
Navy began investigation of the release	1981
Initial site assessment completed	June 1983
Remedial investigation (RI) conducted (RI report completed)	June 1984 to September 1988 (January 1986)
Feasibility study completed Volume I: Remedial Action Alternatives Volume II: Biological Assessment	 July 1988 September 1988
Record of decision/remedial action plan finalized	April 6, 1989
Monitoring plan for contamination remediation completed	April 1989
Preremediation monitoring (baseline conditions report completed)	1991 – monitoring conducted (1994 – report completed)
Remedial action subsites (RASS) 1 and 2 remedial actions (start to finish)	June 1993 – June 1996
RASS 3 remedial action (start to finish)	May 1993 – July 1994
RASS 4 remedial action (start to finish)	January 1993 – June 1994
Explanation of significant difference regarding addition of dewatering unit during remediation	August 1994
National Priorities List status	December 1994
RASSs 1 to 4 final revegetation monitoring plan completed	April 1995
After remediation (Year 1), remedial action monitoring report completed	May 1996
After remediation (Year 2), remedial action monitoring report completed	July 1997
Qualitative ecological assessment report finalized	September 1997
After remediation (Year 3), remedial action monitoring report completed	February 1998
After remediation (Year 4), remedial action monitoring report completed	January 1999
Initiation of 5-year review process	November 1999
After remediation (Year 5), remedial action monitoring completed	January 2000

APPENDIX D

SUMMARY AND EVALUATION OF THE MONITORING PROGRAM
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

(133 Pages)

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D1 POSTREMEDIATION METAL CONCENTRATIONS IN SOIL AND SEDIMENT

D2 SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

ABBREVIATIONS AND ACRONYMS

AWQC	Ambient water quality criteria
BERA	Baseline ecological risk assessment
bgs	below ground surface
CDFG	California Department of Fish and Game
CNDDB	California Natural Diversity Data Base
CNPS	California Native Plant Society
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
ER-L	Effects-range low
ER-M	Effects-range median
FS	Feasibility study
mg/kg	Milligram per kilogram
msl	Mean sea level
Navy	U.S. Department of the Navy
NWSSBD	Naval Weapons Station Seal Beach Detachment
PRC	PRC Environmental Management, Inc.
PST	Pacific standard time
QEA	Qualitative ecological assessment
RASS	Remedial action subsite
RI	Remedial investigation
RWQCB	California Regional Water Quality Control Board
SARAC	Statistically above reference criteria
TOC	Total organic carbon
TtEMI	Tetra Tech EM Inc.
TTLC	Total threshold limit concentration
WCC-c	Wetland creation criteria for cover soil
WCC-nc	Wetland creation criteria for noncover soil
WES	U.S. Army Corps of Engineers, Waterways Experiment Station

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Engineering Field Activity West conducted the first postremediation five-year periodic review assessment at the Litigation Area sites at Naval Weapons Station, Seal Beach Detachment (NWSSBD) Concord, California (Figure 1). The review focused on the four remedial action subsites (RASS) in the Litigation Area (Figure 2). The Navy authorized Tetra Tech EM Inc (TtEMI), formerly PRC Environmental Management, Inc (PRC), to conduct this five-year review under Comprehensive Long-term Environmental Action – Navy Contract No. N62474-94-D-7609, Contract Task Order No. 373. The Navy also conducted a review of the monitoring program, including monitoring objectives and results, and an evaluation of the effectiveness of the program.

This summary includes the monitoring program and presents the basic information needed to (1) document and synthesize existing data on remaining levels of metals and ecological conditions at the site that will be used in assessing the protectiveness of the remedy, and (2) evaluate the effectiveness of the monitoring program and the use of passive remediation and long-term monitoring as part of the remedy.

This appendix also summarizes results of the preremediation monitoring conducted in 1991 and the five years of postremediation monitoring conducted from 1995 through 1999. During preremediation monitoring, environmental samples were collected and ecological surveys were conducted to establish preremediation conditions in the Litigation Area. Results of preremediation monitoring were presented in the baseline conditions report (PRC 1994). The postremediation monitoring program analyzed soil, sediment, and surface water samples for six primary metals on a yearly basis, during the first five years following remedial actions. Ecological surveys of avian, small mammal, and plant receptors present at the Litigation Area were also conducted, along with revegetation monitoring in areas that were disturbed by remedial actions. Postremediation monitoring results were presented in a series of annual reports (PRC 1996, 1997a; TtEMI 1998, 1999, 2000a).

Various special studies and additional characterization activities have been conducted in conjunction with the annual postremediation monitoring activities, including toxicity tests on sediment and sediment pore water samples, storm event sampling, tidal sediment transport sampling, marsh surface accretion-rate sampling, and others. These special studies and additional characterization activities were not considered part of the regular remedial action monitoring activities; as a result, they are not discussed in this

appendix. However, they are included in Appendix E, Evaluation of Existing Sources and Migration of Contaminants, and Appendix G, Baseline Ecological Risk Assessment (BERA).

1.1 GOALS OF THE MONITORING PROGRAM REVIEW

The overall goals of the monitoring program review were as follows:

- Review the monitoring program objectives and evaluate whether objectives were met
- Summarize and synthesize results of pre- and postremediation monitoring
- Compare pre- and postremediation conditions at the site
- Evaluate the effectiveness of each component of the monitoring program in meeting monitoring objectives and overall goals
- Provide recommendations on future monitoring efforts

The monitoring program objectives are listed in the following section. Sections 2.0 through 7.0 summarize monitoring results, analysis of trends, and conclusions of the monitoring program. Although sampling methods varied between pre- and postremediation monitoring, results were summarized in a manner to allow direct comparisons, where possible. The effectiveness of the monitoring program is evaluated in Section 8.0.

1.2 MONITORING PROGRAM OBJECTIVES

To assess the effects and potential migration of contaminated soil that was left in place after remediation, and to evaluate the success of the remedial actions, the Navy developed a monitoring plan as part of its remedial design. The "Monitoring Plan for Contamination Remediation at Naval Weapons Station Concord, California" (Lee and others 1989) was prepared by the U.S. Army Corps of Engineers, Waterways Experiment Station (WES), and is referred to in this report as the WES monitoring plan. The WES monitoring plan established the original objectives of the monitoring program; these objectives were slightly modified for the year 1 sampling event based on evaluation of preremediation data and data collected during remedial activities.

The postremediation monitoring objectives for the Litigation Area were as follows (PRC 1997a):

- Objective 1: Collect data that will assist in evaluating long-term changes in site conditions
- Objective 2: Evaluate potential contaminant migration to Suisun Bay (groundwater, surface water, and sediment)

- Objective 3: Determine if the active remediation areas become recontaminated; if so, determine the extent of recontamination and potential sources
- Objective 4: Evaluate contaminant migration in the unremediated areas
- Objective 5: Monitor the overall habitat quality of the site, including the success of the restoration and use of the site by special status plants and animals
- Objective 6: Determine if groundwater is being impacted by the contamination.

Each year since completion of remedial action construction in 1995, soil, sediment, and surface water samples were collected, and the results were compared with previous years to evaluate long-term changes at the Litigation Area (objective 1). Samples were collected from sediment and surface water in contact with Suisun Bay through ditches and sloughs at the Litigation Area to evaluate the potential for contaminant migration to Suisun Bay (objective 2). Mobility of contaminants may be indicated by contaminant concentrations increasing in certain downstream areas or decreasing at contaminated locations. Special studies to further evaluate migration in these pathways are described in detail in Appendix E.

In support of objectives 3 and 4, chemistry data for years 1 through year 5 were compared to evaluate whether remediated areas were recontaminated and to characterize potential contaminant migration patterns in unremediated areas. Contaminant migration was evaluated by comparing sampling results from one year with the next to identify trends in contaminant concentrations.

In support of objective 5 (monitoring overall habitat quality), annual ecological surveys were conducted to characterize and monitor populations of selected plants and animals and to evaluate the success of revegetation efforts in the remediated areas at the Litigation Area. These surveys focused on special status species such as the endangered salt marsh harvest mouse *(Reithrodontomys raviventris)* and the threatened California Black Rail *(Laterallus jamaicensis coturniculus)*.

Monitoring the impact of contamination on groundwater (objective 6) was addressed in the "Tidal Influence Study and Postremediation Groundwater Monitoring Technical Memorandum" (PRC 1997b) and was not part of the annual monitoring. Additional details on groundwater contamination and migration are provided in Appendix E.

1.3 PREREMEDIATION MONITORING PROGRAM DESIGN

The preremediation monitoring program included both chemical and ecological monitoring. Based on the remedial investigation (RI) conducted at the site (Lee and others 1986), the chemical monitoring program

initially addressed six metals of concern: arsenic, cadmium, copper, lead, selenium, and zinc. The Litigation Area and the two reference areas were overlaid with a 100-foot grid system to facilitate consistent location of the samples. Most chemical sampling locations (approximately 75 percent) were concentrated along the boundaries between the active remediation areas, passive remediation areas, and monitoring areas (Figure 11). Approximately 25 percent of the chemical sampling locations were randomly placed throughout the active, passive, and monitoring areas.

1.4 PREREMEDIATION MONITORING METHODS

Chemical samples were collected from surface soil, sediment, and surface water. Surface soil and sediment samples were collected from 0 to 0.5 foot below ground surface (bgs). Several subsurface soil samples were collected from 0.5 to 1.0 and 1.0 to 1.5 feet bgs from areas where additional subsurface characterization was needed; however, these samples were not part of the regular monitoring program. Sediment samples were collected from 0 to 0.5 foot below the sediment surface in the bottom of the creek, ditches, sloughs, and ponds. Surface water samples were collected from overlying water at each sediment sampling location. Three replicate samples were collected at the same time at each soil and sediment sampling location to evaluate sample variability. Three rounds of surface water sampling were conducted at each location with approximately 16 days between the rounds.

Preremediation ecological monitoring included vegetation, small mammal, and rail surveys. Vegetation surveys included vegetation characterization, plant community mapping, and a special status plant survey. The plant community mapping and special status plant survey were conducted throughout the Litigation Area. Vegetation characterization and small mammal surveys were conducted at 85 soil sampling locations. These locations are circled in red on Figure 11. For the small mammal surveys, several individual trapping sites were randomly located within a 100-by-100-foot grid at each location. The rail surveys were conducted along transects established in each of the four RASSs.

1.5 POSTREMEDIATION MONITORING PROGRAM DESIGN

The postremediation monitoring program also included both chemical and ecological monitoring; however, changes to the design of the program were made based on results of data collected before and during remediation. The Navy met with U.S. Environmental Protection Agency (EPA) and other agencies to discuss concerns about the monitoring program and to develop a revised monitoring program. Some of the concerns included (1) the biased nature of the sampling design, (2) the lack of samples in sloughs or ditches and other parts of the site, (3) the high variability of the existing chemistry data and the feasibility of assessing changes using the original design, and (4) the artificial distinction between the

monitoring and passive areas since both areas were contaminated. The Navy agreed to add many more sampling locations across the site, including at the sloughs and ditches where few samples had been collected. The design was also changed to include randomly selected sampling locations, where possible, and single, rather than triplicate, samples at each location. The Navy and the agencies agreed that this approach would allow for better characterization of contaminant levels at a broader spatial scale across the site. Postremediation monitoring results were presented in a series of annual reports (PRC 1996, 1997a; TtEMI 1998, 1999, 2000).

After evaluating preremediation data, the following changes were made to the postremediation monitoring program design:

1. **Soil sampling locations were revised**. During preremediation monitoring, most soil sampling locations were regularly placed on borders between passive and monitoring areas; however, baseline data indicated that no significant difference in contamination exists between the passive and monitoring areas. Instead, the only defined border is between the active remediation area and the remaining unremediated area. As a result, revised soil sampling locations were selected using a stratified random approach, and were located (1) within the active remediation areas, (2) along the borders between the active remediation areas and the remaining RASS area, and (3) within the remaining unremediated area. The terms "passive remediation area" and "monitoring area" were abandoned and both areas were referred to as unremediated areas and were subject to intensive monitoring. The Litigation Area was divided into 16 spatial units to aid in statistical evaluation of changes in concentrations (Figure 12).

2. **Triplicate samples were no longer collected at each soil sampling location.** Preremediation monitoring data indicated that high variability exists within the three triplicate surface soil samples collected from the same location. Rather than focusing on replicate samples from single locations, single samples were collected from more locations at a broader spatial scale for postremediation monitoring.

3. **Small mammal trapping at individual sampled locations were replaced by trapping transects and grids.** Use of trapping transects and grids allowed for more representative sampling of small mammal distribution across the site.

4. **Vegetation bioaccumulation sampling was discontinued.** The postremedial monitoring program did not include vegetation bioaccumulation after the preremediation baseline was established, except as a contingency action. However, limited pickleweed (*Salicornia virginica*) vegetation bioaccumulation studies were conducted in conjunction with year 1 monitoring to support the QEA (PRC 1997c).

5. **Litigation Area was divided into spatial units.** Early in the postremediation program, the Litigation Area was divided into 16 spatial units (Figure 12). Spatial units were prioritized based on chemical concentrations and migration potential. Sampled locations were grouped into spatial units based on similar characteristics such as geographic location, concentrations of metals, and habitat characteristics (for example, marsh or upland). This prioritization was used to determine the number of samples required per spatial unit based on a statistical power analysis of sample size needed to detect significant change (PRC 1997a). The purpose of these spatial units was to provide a means to identify spatial changes in contaminant concentrations over time in soil, sediment, and surface water. Spatial Units 1, 2, 4, 6, 8, 12, 14, and 16 are soil sampling units from the areas shown on Figure 12. The remaining spatial units (Units 3, 5, 7, 9, 10, 11, 13, and 15) were sediment sampling units that included sediment and surface water samples collected from ditches, sloughs, creeks, or ponds in the areas indicated on Figure 12.

1.6 POSTREMEDIATION MONITORING METHODS

Postremediation chemical monitoring included the same six metals of concern used for preremediation monitoring (arsenic, cadmium, copper, lead, selenium, and zinc); mercury analysis was added for RASS 4 samples because the qualitative ecological assessment (QEA) (PRC 1997c) identified mercury in RASS 4 as a potential risk to ecological receptors. Soil and sediment samples were also analyzed for pH, conductivity, interstitial salinity, total organic carbon (TOC), and grain size. Chemical samples were collected from surface soil and sediment and surface water (Figure 12). Surface soil and sediment samples were collected from 0 to 0.5 foot bgs. Each soil sampling location shown on the figure actually represented the corner (typically the northeast corner) of a 100- by 100-foot sample grid. The soil sample was collected from within the sample grid at a quadrat that was randomly selected each year. Sediment samples, which are collected from sloughs, ditches, and ponds, were all fixed sampling locations that did not vary from year to year. Surface water samples were collected at each sediment sampling location and analyzed for the same metals as sediment samples. Surface water was also analyzed in the field for pH, conductivity, temperature, turbidity, salinity, and dissolved oxygen content.

The postremediation ecological monitoring followed up on many of the baseline surveys conducted during the preremediation survey, and included vegetation, small mammal, and California Black Rail monitoring. In addition, a revegetation program was established to monitor the success of revegetation efforts in portions of each RASS site that had been disturbed by remedial actions. Vegetation characterization also took place at small mammal trapping locations, and special status plant surveys were conducted throughout the Litigation Area. Small mammal trapping was conducted along trapping transects, and trapping grids established in each RASS, rather than at individual soil sampling locations as was done in the preremediation monitoring. The Black Rail surveys were conducted on the same

transects established for the preremediation survey. Postremediation transects and grids established for ecological monitoring are shown on Figure 21.

In 1995, the Navy finalized the plan for monitoring the success of the revegetation and restoration of the actively remediated areas (H.T. Harvey 1995). This plan established success criteria for the different revegetation efforts in the active remediation areas of each RASS. Monitoring of revegetation success was conducted in each year of annual monitoring.

1.7 CHANGES TO THE POSTREMEDIATION MONITORING PROGRAM

Throughout the postremediation monitoring, changes were made based on the previous years' monitoring results and discussions with the agencies. Additional sampling or special studies were also conducted to address specific concerns about the site. These additions or changes included:

- Year 2: Sampling locations were added in areas of concern, such as the slough, that had not been adequately represented in the original monitoring design. For this reason, sample size and some sampling locations for year 1 differed from those for years 2, 3, 4, and 5. Sample sizes were increased after year 1. Analysis of mercury in surface water, soil, and sediment samples collected in RASS 4 was added because the QEA (PRC 1997c) identified mercury as a chemical of concern in RASS 4. Analysis of TOC in soil and sediment samples was added to evaluate the mobility of metals in soil.

- Year 3: Turbidity and salinity measurements were added to surface water samples, in addition to pH, conductivity, temperature, and dissolved oxygen.

- Year 4: Additional studies were implemented, including profiles of the mosquito abatement ditches and winter surface water sampling in Nichols Creek. Filtered (dissolved) surface water chemistry samples were added at a subset of the surface water sampling locations.

- Year 5: Additional surface water studies included a winter storm event sampling, which included both filtered and unfiltered surface water sampling, and the installation of a sensor to measure turbidity and other parameters; hardness was added to the parameters analyzed. A pollen and lead study was conducted using lead-210 and palynological techniques to determine sediment accretion rates on the marsh surface.

Ecological characterization and toxicity assessment activities have also undergone some changes or additions, including:

- Year 2: The characterization of benthic invertebrates was discontinued after year 1; because of natural variability in the composition of the benthic community, that endpoint was not considered a reliable indicator of contaminant effects. New trapping grids were added to the small mammal characterization in year 2 to assess the recolonization of remediated areas by small mammals.

- Year 3: Sea urchin development tests were conducted on pore water from nine locations in Lost Slough and in the RASS 3 pond area.

- Year 4: Special status plant species were mapped using global positioning system and sediment-water interface toxicity tests using topsmelt embryos were conducted on 10 sediment samples from Lost Slough.

1.8 REFERENCE AREAS

During the RI and feasibility study (FS), two reference areas were identified and used for comparative purposes to evaluate conditions at the site and, in the case of RASS 3, to identify cleanup criteria. The upland reference area is composed of upland soils, next to Nichols Creek and upgradient from the Chemical and Pigment plant source (Figures 2 and 10 [Site BK133]). The area was also used as an upland reference area in the QEA (PRC 1997c) and during the monitoring program (referred to as Unit 16). Concentrations of chemicals in the upland reference area have typically been much lower than those concentrations in the rest of the Litigation Area upland habitat.

A shoreline reference area established for the RI and FS was west of the Litigation Area (Figure 2). During the first year of monitoring and the QEA, it was determined that metal concentrations in the shoreline reference area were above screening values and that wetland habitat was not similar to the Litigation Area (PRC 1997c). In addition, the Navy evaluated the suitability of neighboring marshes along the southern coast of Suisun Bay for use as a marsh reference area. The southern shore of Suisun Bay is heavily industrialized with chemical plants and oil refineries on both sides of NWSSBD Concord. The northern shore of Suisun Bay is less industrialized, but differs in hydrology and species composition of the wetland habitat; it therefore was not considered a suitable reference area. Regulatory and trustee agencies agreed that finding an off-site, unaffected area with similar habitat was not feasible. A new marsh reference area was established in 1995 in the northwestern corner of the Litigation Area in wetland habitat that is more typical of the rest of the site (Figures 2 and 10). Relatively low concentrations of metals have been measured in the marsh reference area (also referred to as Unit 1) during the monitoring program, and the area is not considered to be significantly affected by historical spills at the site. The area was considered a suitable reference area for comparative purposes for the evaluation of data from the marsh surface in the rest of the Litigation Area.

1.9 SPATIAL UNITS

The Litigation Area was divided into spatial units for sampling under the monitoring program (Figure 12). The spatial units are described below:

- **Marsh Surface Reference Area (Unit 1):** To evaluate site conditions, the northwestern corner of the marsh was proposed as the marsh reference area in 1995. The unit is relatively far from the source of contamination and probably represents regional ambient conditions related to deposition of chemicals from Suisun Bay or other sources.

- **Northern Marsh Surface (Unit 2):** The northern marsh surface unit is bordered on the north by Suisun Bay, on the west and south by Lost Slough, and on the east by General Chemical property; the unit is tidally inundated.

- **Northern Ditches (Unit 3):** The northern marsh is bisected by a series of manmade mosquito ditches, which are tidally influenced, where sediment and surface water has been sampled.

- **Southwestern Marsh Surface (Unit 4):** The area lies on the southwestern side of RASS 1 and is bordered by the northern and central reaches of Lost Slough on the north and east, Stevens road on the west, and the railroad track berm on the south; the unit is tidally inundated.

- **Southwestern Ditches (Unit 5):** The southwestern marsh is bisected by a series of manmade mosquito ditches, which are tidally inundated, where sediment and surface water has been sampled.

- **Central Marsh Surface (Unit 6):** The central marsh is located just west of the RASS 1 remediated area (Unit 8), bordered by the transitional upland area of Unit 12 to the south, Lost Slough to the west, and to the north is separated from the northern marsh (Units 2 and 3) by a small slough.

- **Central Ditches (Unit 7):** The central marsh is bisected by a series of manmade mosquito ditches, which are tidally inundated, where sediment and surface water has been sampled.

- **RASS 1 Remediated Area (Unit 8):** The marsh surface to the east of the central marsh and west of General Chemical property; this area was remediated to remove metals-contaminated soils.

- **Northern Lost Slough (Unit 9):** A natural tidal channel meandering through the Litigation Area marsh. The northern reach is closest to Suisun Bay and includes the mouth of the slough where it meets the bay.

- **Central Lost Slough (Unit 10):** The central reach of Lost Slough lies in a north-south orientation between the central and southeastern marsh; the portion of the slough is tidally connected to the RASS 3 pond through a small mosquito ditch.

- **Southwestern Reach of Lost Slough (Unit 11):** The smaller southwestern reach of Lost Slough runs westerly across Unit 4 and is a blind slough that narrows near its end on the western side of RASS 1.

- **RASS 2 Transitional Uplands (Unit 12):** This area consists of wetland and transitional upland between RASS 1 and the railroad berm; part of this unit includes the remediated area of RASS 2.

- **Nichols Creek and Pond (Unit 13):** Nichols Creek is a seasonal creek in RASS 3 that drains from the nearby hills and flows through the grassland habitat of Unit 13 into the RASS 3 pond, and eventually into Lost Slough. This area includes the remediated portion of RASS 3. Elevations range from approximately 27 feet above mean sea level (msl) in the southeastern area to approximately 7 feet above msl on the edge of the tidally influenced pond in the northwestern area.

- **RASS 4 Upland (Unit 14):** RASS 4 is approximately 0.5 mile east of the other RASSs, and consists of upland habitat; part of Unit 14 includes the remediated area in RASS 4.

- **RASS 4 Wetland (Unit 15):** The emergent nontidal wetland in the eastern part of RASS 4 receives water from a drainage ditch from the surrounding upland habitat and housing development in the eastern part of RASS 4.

- **Upland Reference Area (Unit 16):** The upland reference area is bounded on the north by Port Chicago Highway and on the south by the Contra Costa Canal. This area is relatively far from, and upgradient of, the source of contamination and was therefore probably represents regional ambient conditions related to deposition of chemicals from upland or other sources.

2.0 SEDIMENT AND SOIL CHEMISTRY

The following sections summarize and compare pre- and postremediation monitoring results for soil and sediment chemistry and evaluate trends in postremediation chemical concentrations. Sediment and soil chemistry results were compared with the effects-range low (ER-L) and effects-range median (ER-M) (Long and others 1995). For selenium, since an ER-L and ER-M are not available, wetland creation criteria for cover (WCC-c) and noncover (WWC-nc) were used (California Regional Water Quality Control Board [RWQCB] 1992).

2.1 PREREMEDIATION SOIL AND SEDIMENT MONITORING

In accordance with the provisions of the WES monitoring plan (Lee and others 1989), the Navy collected environmental samples in 1991 to establish preremediation conditions at the Litigation Area. Results of the sampling event were summarized in the baseline conditions report (PRC 1994).

Figure 11 indicates the location of preremediation samples. As shown on the figure, no preremediation sediment or soil samples were collected in the southwestern portion of RASS 1 (Units 4, 5, and 11),

which was not considered part of the monitoring program at the time. No samples were collected from the active remediation areas (Unit 8 and portions of Units 12, 13, and 14), since these areas were going to be excavated during remediation.

2.1.1 Preremediation Soil Results

Table 13 summarizes results of the preremediation surface soil samples grouped by spatial unit designation that were developed in the postremediation monitoring. Metal concentrations shown in the table are the average of three replicate samples collected at each location. As shown on Figure 11, soil samples in Units 2 and 6 were from the northern and central marsh surface. Soil samples in Unit 12 were from the southern upland surface (RASS 2), and Unit 13 samples were from the upland areas along Nichols Creek. Unit 14 soil samples were from the upland surface in RASS 4, and Unit 16 samples were from upland reference area surface soils.

Some of the lowest concentrations of metals in the Litigation Area were detected in soil from Unit 2. None of the 34 samples collected exceeded the ER-M for cadmium or lead; however, arsenic, copper, and zinc did exceed the ER-M at several locations. Selenium exceeded the ER-M at half of the locations, which is typical throughout the Litigation Area.

The highest concentrations of metals in the Litigation Area were detected in soil from Unit 6 (central marsh). The average concentrations of arsenic and copper in Unit 6 were the highest of all six surface soil units sampled during preremediation monitoring, with arsenic exceeding four times the ER-M at 17 of the 46 sampling locations.

Zinc was the primary contaminant detected in Unit 12, exceeding the ER-M in 22 of 27 samples; many of the samples were detected at concentrations exceeding four times the ER-M. Copper and lead were also detected at high concentrations in Unit 12.

Concentrations of metals in soil from Unit 13 were generally low, except for lead and zinc. The average concentrations of lead in Unit 13 were the highest of all six surface soil units sampled during preremediation monitoring; however, the high average was primarily because of unusually high results at only 3 of the 38 sampling locations. Zinc exceeded the ER-M at 15 of the 38 sampling locations.

Concentrations of metals in soil from Unit 14 were generally low, except for selenium. The average concentrations of selenium in Unit 14 were the highest of all six surface soil units sampled during preremediation monitoring.

Unit 16 (upland reference area) surface soil exhibited low concentrations of metals. None of the four samples collected had concentrations of metal exceeding the ER-M.

2.1.2 Preremediation Sediment Results

Table 14 summarizes the results of the preremediation sediment samples grouped by spatial unit. As shown on Figure 11, sediment samples in Units 3 and 7 were from mosquito abatement ditches in the northern and central portions of RASS 1. Samples in Units 9 and 10 were from the northern and central reaches of Lost Slough, and samples in Unit 13 were from Nichols Creek and the RASS 3 pond. Unit 15 samples were from the RASS 4 wetland. Similar to soil results, sediment results shown in Table 14 were the average of three replicate samples.

Only two locations in the northern marsh ditches (Unit 3) were sampled during the preremediation monitoring. Concentrations of arsenic, selenium, and zinc exceeded the ER-M in both locations. Both locations are adjacent to the more contaminated central marsh. None of the other metals exceeded the ER-M.

Sediment samples collected in mosquito ditches in Unit 7 contained the highest average concentrations of arsenic and copper in all six sediment units sampled during preremediation monitoring. However, both metals were lower than the concentrations found in Unit 6 soil. High concentrations of cadmium, selenium, and zinc were also found in Unit 7, and concentrations regularly exceeded the ER-M values.

Unit 9, the northern reach of Lost Slough, exhibited low concentrations of metals. This stretch of Lost Slough is in direct contact with Suisun Bay. None of the three samples from the unit had concentrations of metals that exceeded the ER-M.

Unit 10, the central reach of Lost Slough, had higher concentrations of each metal than Unit 9. This unit had the highest average concentrations of cadmium and zinc sampled during preremediation monitoring.

Nichols Creek is a seasonal creek in RASS 3 that drains from the nearby hills and flows through the grassland habitat of Unit 13, into a pond, and eventually into Lost Slough. The primary contaminants in Unit 13 sediment were lead and zinc. The highest preremediation concentrations of lead and zinc occurred at two locations, R03SH187 and R03SH189, adjacent to the Chemical and Pigment Company property.

Unit 15 had low concentrations of all metals, except selenium and zinc. Both metals exceeded the ER-M in two of four sampling locations. The average concentration of selenium in Unit 15 was the highest of all six sediment units sampled during preremediation monitoring.

2.2 POSTREMEDIATION SOIL AND SEDIMENT MONITORING RESULTS

The Navy conducted 5 years of annual postremediation monitoring, including the annual collection of 98 soil and 134 sediment samples. Figure 12 shows the postremediation sampling locations and the 16 spatial units. Results presented in this section are discussed by spatial unit.

Table 15 presents the average concentration of metals in surface soil in each spatial unit for each of the 5 years of postremediation monitoring. The cumulative average for the 5-year period is also included in Table 15. Table 16 presents the same information for sediment results. Attachment D1 contains complete data tables and box plots that show the metal concentration in soil and sediment at each location, for each of the 5 years of postremediation monitoring. Sampling locations in these data tables are also grouped by spatial unit, with an associated chart that shows the range, average, and standard deviation of concentrations graphically at each sampling location. Box plots in Attachment D1 show the variability in metals concentrations on the scale of the sampling location.

Postremediation metals concentrations in soil and sediment were also summarized compared with ER-Ls and ER-Ms in 12 maps (Figures 22 through 33). These maps use the following color code to indicate the concentration (compared with the benchmark value) at each location for each year of monitoring:

- Blue: less than the ER-L
- Green: less than the ER-M but greater than or equal to the ER-L
- Yellow: less than two times the ER-M but greater than or equal to the ER-M
- Orange: less than four times the ER-M but greater than or equal to two times the ER-M
- Red: greater than or equal to four times the ER-M

Two maps are available for each metal contaminant: one showing RASSs 1 and 2 and one showing RASS 3 and 4.

2.2.1 Marsh Area (Units 1 through 8)

The marsh covers about three-fourths of the Litigation Area and is one of a limited number of remaining tidal wetlands along the southern shore of Suisun Bay. The marsh consists of tidally influenced wetlands, encompassing all of RASS 1. The marsh is bordered on the north by Suisun Bay and on the south by transition to upland habitats, along the northern edge of RASS 2 and the railroad berm, which generally runs east and west through the Litigation Area. To the east lies the General Chemical facility, with a berm separating it from the marsh. The western boundary is Stevens Road that runs north and south adjacent to Lost Slough.

Marsh Reference Area (Unit 1)

The northwestern corner of the marsh was proposed as the marsh reference area in 1995. The unit is relatively far from the source of contamination and probably represents regional ambient conditions related to deposition of chemicals from Suisun Bay or other sources. Analyses of five surface soil samples collected in Unit 1 each year since 1995 have shown that the area was not completely unaffected by metals. Metal concentrations above ER-Ls were present in Unit 1; however, with the exception of selenium, no metals concentrations have exceeded the ER-Ms. Selenium concentrations above the WCC-nc have been detected at three of five sampling locations in Unit 1. The marsh reference area has relatively low levels of contamination, and metals concentrations have remained generally stable over 5 years of postremediation monitoring. Unit 1 was therefore considered to represent a relatively uncontaminated area and can be used for comparative purposes.

Northern Marsh (Units 2 and 3)

The northern marsh is bordered on the north by Suisun Bay, on the west and south by Lost Slough, and on the east by General Chemical property. Unit 2 is the marsh surface, and Unit 3 is the mosquito ditches that occur throughout the northern marsh.

Ten soil locations sampled in Unit 2 have consistently reported some of the lowest concentrations of metals in the Litigation Area. In years 1 through 5, of the 50 surface soil samples collected in Unit 2, only arsenic (6), lead (1), selenium (23), and zinc (4) were detected at concentrations exceeding the ER-M; cadmium and copper were not detected at concentrations exceeding the ER-M. Arsenic was regularly detected at concentrations exceeding the ER-M at location R01SS037. This location is adjacent to the central marsh, which exhibited the highest concentrations of metals in RASS 1. As in the marsh reference area, selenium regularly exceeded the WCC-nc.

Sediments in the northern marsh ditches (Unit 3) appear relatively unaffected by contamination. Of the 50 samples collected over 5 years in Unit 3, arsenic was detected in three samples at concentrations exceeding the ER-M, and copper was detected in one sample. Selenium and zinc concentrations in Unit 3 were elevated in a few locations adjacent to the central marsh.

Southwestern Marsh (Units 4 and 5)

Units 4 and 5 are in the southwestern marsh. The area lies west of the central marsh and is bordered by the northern and central reaches of Lost Slough on the north and east, Stevens Road on the west, and the railroad track berm on the south.

Elevated concentrations of selenium and zinc were detected in the southwestern marsh. Zinc is believed to have migrated downstream from RASS 3, along Nichols Creek, and into ditches and surrounding soil in the southwestern portion of RASS 1. Unit 4 is the marsh surface, and Unit 5 includes the network of mosquito ditches in this area.

Concentrations of metals in Unit 4 surface soils varied little during postremediation monitoring. High concentrations of zinc were typically detected in Unit 4. Of the 59 samples collected over 5 years, zinc was detected in 29 samples at concentrations exceeding the ER-M, and eight of those samples exceeded four times the ER-M. Concentrations of arsenic, cadmium, copper, and lead have typically been low. Of the 59 soil samples collected over 5 years, arsenic was detected in eight samples at concentrations exceeding the ER-M, and lead was detected in three samples at concentrations exceeding the ER-M. Cadmium and copper were not detected at concentrations exceeding the ER-M. Selenium results have typically exceeded the WCC-nc.

Similar to Unit 4 soils, sediments in southwestern marsh ditches (Unit 5) contained low concentrations of most metals, except for selenium and zinc. The average concentration of zinc in Unit 5 decreased steadily over the 5 years of monitoring. For example, the average concentration of zinc has declined each year from a high in year 1 of 1,341 milligrams/kilograms (mg/kg) to a low in year 5 of 479 mg/kg. However, of the 30 samples collected in Unit 5 over 5 years, zinc was detected in 22 samples at concentrations exceeding the ER-M, and 5 of those samples exceeded four times the ER-M.

Central Marsh (Units 6 and 7)

The central marsh had the highest concentrations of metals in the Litigation Area. The central marsh is west of the RASS 1 remediated area (Unit 8), bordered by the transitional upland area of Unit 12 to the

south, Lost Slough to the west, and to the north is separated from the northern marsh (Units 2 and 3) by a small slough. Likely sources for high concentrations of arsenic, cadmium, copper, selenium, and zinc include former operations on the adjacent General Chemical site (Cullinane and others 1988). Historical aerial photographs show discoloration and distressed vegetation in this area over the last 50 years (Figures 5 through 9).

The average concentrations of arsenic and copper in Unit 6 were the highest of all eight surface soil units. Arsenic concentrations often exceeded four times the ER-M at several locations in Unit 6. Concentrations of lead, selenium, and zinc were also high and regularly exceeded the ER-M at several locations. Average metal concentrations in Units 6 have been relatively consistent over the 5 years of monitoring.

Sediment samples collected in Unit 7 mosquito ditches contained the highest mean concentrations of arsenic and copper in the Litigation Area. High concentrations of cadmium, selenium, and zinc were also detected in Unit 7, regularly exceeding the ER-M. The highest concentrations of metals were detected just west of the remediated area, nearest the former waste lagoons at General Chemical that were the original source. Lead was consistently detected in relatively low concentrations in Unit 7, with few samples that exceeded the ER-M during postremediation monitoring. Of 89 sediment samples collected in Unit 7 over 5 years, lead was detected in only four samples at concentrations exceeding lead ER-M.

RASS 1 Remediated Area (Unit 8)

Unit 8 is to the east of the central marsh and west of the General Chemical property. The entire unit was remediated, and soil that exceeded total threshold limit concentration (TTLC) and soluble threshold limit concentration criteria was excavated and transported off site for disposal. Relatively clean fill was added to Unit 8, and the area was revegetated. The main purpose of sampling in this unit was to evaluate whether Unit 8 was becoming recontaminated from neighboring off-site sources or unremediated areas in the Litigation Area.

Results of surface soil sampling have remained relatively consistent over the five-year monitoring program. No samples exceeded the ER-M for arsenic, cadmium, copper, lead, and zinc. As with the other relatively uncontaminated areas of the marsh, concentrations of selenium occasionally exceeded the ER-M.

2.2.2 Sediment Results in Lost Slough (Units 9 Through 11)

Lost Slough is a natural waterway meandering through the Litigation Area marsh. Fresh water flows into the slough through Nichols Creek and pond, while the tide brings in brackish water from Suisun Bay. Lost Slough is divided into three spatial units, Units 9, 10, and 11, that are discussed separately below.

RASS 1 Northern Reach (Unit 9)

Unit 9, the northern reach of Lost Slough, has historically exhibited low concentrations of metals. This stretch of Lost Slough is in direct contact with Suisun Bay, and any migrating metals contamination from the wetland would pass through this unit before reaching Suisun Bay.

Sediments in the northern reach of Lost Slough have had consistently low concentrations of metals and do not appear to be getting more contaminated. Concentrations of arsenic, cadmium, copper, and lead were typically below the ER-M throughout Unit 9 and were relatively consistent over the postremediation period. Zinc concentrations were also generally below the ER-M; however, zinc was detected at a few locations (such as R01SH224) at concentrations that regularly exceeded the ER-M in years 2, 4, and 5.

Similar to the other units in the marsh, selenium concentrations often exceeded the WCC-nc at many of the sampling locations.

RASS 1 Central Reach (Unit 10)

Unit 10, the central reach of Lost Slough, has historically shown higher concentrations of arsenic, cadmium, copper, lead, selenium, and zinc than in Unit 9. In general, zinc concentrations were highest in the southern portion of Unit 10, while high concentrations of arsenic, cadmium, and selenium were more generally distributed throughout the unit, probably reflecting their spatial relationship to the original sources.

RASS 1 Southwestern Reach (Unit 11)

The southwestern reach of Lost Slough follows a meandering path to the west. Sediments contained high concentrations of zinc throughout Unit 11 as wells as localized high concentrations of arsenic and cadmium. Concentrations of zinc, and occasionally cadmium, exceeded four times the ER-M at many sampling locations in Unit 11.

2.2.3 Nichols Creek and Pond (Unit 13)

Nichols Creek is a seasonal creek in RASS 3 that drains from the nearby hills and flows through the grassland habitat of Unit 13, into a pond, and eventually into Lost Slough. Nichols Creek is typically dry from August through October. While upland habitat exists in RASS 3, monitoring samples have been focused on Nichols Creek because of concerns about the migration of contaminants.

The primary contaminant in RASS 3 (Unit 13) sediment was zinc. Some of the highest concentrations of zinc occurred in the remediated area of RASS 3 and the adjacent soils. Zinc contamination at RASS 3 is attributed to historical sources on adjacent properties, specifically the Chemical and Pigment Company (Cullinane and others 1988).

Despite the remediation that occurred from 1990 to 1995, high concentrations of zinc were still detected in the remediated areas because the remediation goals used during that time (for zinc, TTLC of 5,000 mg/kg [wet weight] and statistically above reference area criteria (SARAC) of 2,512 mg/kg [dry weight]) were much higher than the ER-M for zinc (410 mg/kg). The highest concentrations of zinc in Unit 13 were generally found in the sediments of Nichols Creek, beginning near the northern edge of the Chemical and Pigment Company property.

High concentrations of zinc were consistently found throughout Nichols Creek. Typically, about two out of three samples collected exceeded the ER for zinc, and a quarter of the samples exceeded four times the ER-M for zinc. Other metal concentrations were quite low and seldom exceeded ER-Ms.

Zinc concentrations relative to ER-Ls and ER-Ms are shown on Figures 32 and 33 for each sampling location in Nichols Creek and the ponded wetland in RASS 3 for each year of postremediation monitoring. This figure geographically shows the relatively uncontaminated locations above the Chemical and Pigment Company. The highest zinc concentrations were detected in the ponded wetland and in the creek margins on Navy property near the Chemical and Pigment Company.

2.2.4 Upland Areas (Units 12, 14, 15, and 16)

The Litigation Area transitions to upland habitat south of the RASS 1 marsh. The upland area is generally defined as those areas higher than 5 feet above msl. Most of the upland area is disturbed grassland, with some areas covered by shrubs and coyote bush (*Baccharis pilularis*) (PRC 1997a). A small wetland in RASS 4 (Unit 15) was also included in this discussion.

RASS 2 Southern Uplands (Unit 12)

Unit 12 consists of transitional uplands between the marsh and railroad berm in RASS 2. Based on analytical data, the zinc was the primary contaminant detected in Unit 12. A potential source of zinc contamination was the Chemical and Pigment Company, which operated a wastewater lagoon and waste burial area adjacent to Nichols Creek. Contaminants may have migrated to Unit 12 through Nichols Creek, since historically the creek ran under the Southern Pacific Transportation Company railroad tracks into Unit 12, where it often ponded (Ecology and Environment, Inc. 1983). When the culvert under the tracks became plugged, the stream established a new outlet further west, where it currently flows into the RASS 3 pond in Unit 13 and eventually into Lost Slough. Some of the highest concentrations of zinc occurred in the remediated area of RASS 2 because the remedial value used for soil excavation (TTLC of 5,000 mg/kg wet weight) was higher than the ER-M (410 mg/kg).

Zinc concentrations detected in soil samples from Unit 12 typically exceeded the ER-M in about one in four samples. Concentrations of other metals were generally low but occasionally exceeded the ER-M.

RASS 4 Upland (Units 14)

RASS 4 is approximately 0.5 mile east of the other RASSs, and consists of a western upland area (Unit 14), with an emergent nontidal wetland in the eastern area (Unit 15). The average elevation is approximately 20 feet above msl in the western upland area (PRC 1996). The nontidal wetland is fed by a drainage ditch from the surrounding upland habitat and housing development.

Some of the highest concentrations of selenium occurred in the remediated area of RASS 4; however, concentrations can be attributed to the remediation goal (TTLC of 100 mg/kg), which was higher than WCC-nc (1.4 mg/kg). The source of selenium contamination may have been the historical presence of coke pile debris. Mercury concentrations exceeded the ER-M in approximately 35 percent of the soil samples in Unit 14. The source of mercury in RASS 4 is not known, but may be related to mercury recently discovered in an area of concern site (AOC1) immediately to the west.

High concentrations of lead, mercury, and selenium were detected at a few locations in Unit 14. High concentrations of lead were detected in the central area of Unit 14 at locations R04SS200 and R04SS202. Mercury and selenium were also particularly high in that area. Arsenic, cadmium, copper, and zinc were not detected at high concentrations in Unit 14, and measured concentrations have remained relatively consistent.

RASS 4 Wetland (Unit 15)

In contrast with Unit 14, Unit 15 has had low concentrations of all metals, except selenium. Arsenic, cadmium, copper, lead, mercury, and zinc were not detected at high concentrations in sediment. Mercury exceeded the ER-M in only 1 sample of 23 samples (less than 5 percent), much less than in Unit 14. In the 5 years of monitoring, the six metals were detected at concentrations exceeding the ER-M in only 2 out of 24 samples had concentrations of the six metals.

Selenium had the highest concentrations compared with ER-Ls and ER-Ms of the metals in Unit 15. Selenium typically exceeded the WCC-nc value at several locations each year.

Upland Reference Area (Unit 16)

The upland reference area is generally bound on the north by the Port Chicago Highway and on the south by the Contra Costa Canal. This area was relatively far from, and upgradient of, the source of contamination and therefore was proposed to represent regional ambient conditions related to deposition of chemicals from upland or other sources. Analyses of five surface soil samples collected in the upland reference area each year since 1995 have shown that some metals were detected at concentrations exceeding ER-Ls; however, no exceedances of the ER-M for any of these metals exist. This area was considered to represent a relatively uncontaminated area and is used for comparative purposes. Unit 16 surface soil exhibited low concentrations of metals. The average concentration of each of the metals was relatively constant, which suggests that Unit 16 is not being further contaminated.

2.3 EVALUATION OF TRENDS IN SOIL AND SEDIMENT MONITORING RESULTS

The postremediation monitoring program was designed to monitor metals concentrations and detect trends at the spatial unit scale, as described in Section 1.4. However, comparisons at the sampling location scale (location by location) have also been made, where possible, in an attempt to identify hotspots and localized trends that might not have been apparent at the spatial unit scale. The ability to detect changes using location-by-location analysis was somewhat limited by the relatively high natural variability in metals concentrations in the Litigation Area. Metals concentrations varied considerably on the scale of inches both laterally and vertically. As previously described, soil samples were collected each year at different, randomly selected locations within a 100–by-100-foot sample grid, the corner of which is identified on maps as the sampling location. Sediment samples were collected at the same

location each year; however, sediment is a dynamic medium; mobility of sediments in ditch, slough, and creek bottoms is likely to add substantial natural variability.

2.3.1 Comparing Pre- and Postremediation Soil and Sediment Monitoring Results

Comparing concentrations between individual sampling locations was not possible because of changes in sampling locations and sampling design between pre- and postremediation monitoring. Few of the preremediation sampling locations were near the postremediation locations, as shown in Table 13. However, comparisons of average concentrations within a spatial unit are shown in Table 17. This table presents the average pre- and postremediation metal concentrations for each of the soil spatial units, except for Units 4 and 8. For these two units, no comparisons could be made since no preremediation samples were collected, as described in Section 2.1. Concentrations in Table 17 have been shaded when the preremediation and postremediation averages differed by least 20 percent. Table 17 also shows that the average postremediation concentrations were generally lower than the preremediation concentrations. However, because preremediation sampling locations were concentrated near the passive and active and passive and monitoring area boundaries, and postremediation samples were more generally distributed through the spatial units, no definite conclusions could be made as to the meaning of the lower postremediation averages.

Average preremediation and postremediation metal concentrations in sediment spatial units are compared in Table 18. Sediment Spatial Units 5 and 11 could not be compared because of a lack of preremediation sampling in these units, as described in Section 2.1. Most of the preremediation sampling locations were the same as the postremediation locations, as shown in Table 14. However, as shown in Table 18, the preremediation monitoring had far fewer sediment sampling locations. Table 18 also shows that the average postremediation concentrations were generally lower than the preremediation concentrations, except for Spatial Units 7 and 9, where three of the six postremediation metal concentrations were higher and three were lower. This comparison suggests that remedial efforts may have resulted in a general decrease in metals concentrations in Units 3, 10, 13, and 15 and in no consistent change in Units 7 and 9. However, because fewer preremediation samples were available relative to the number postremediation samples, the average concentrations may be substantially biased; as a result, no definite conclusions can be made as to the meaning of the typically lower postremediation averages.

2.3.2 Spatial Unit Scale

A statistical evaluation of spatial and temporal trends over the 5 years of postremediation monitoring was completed as part of the Year 5 monitoring report (TtEMI 2000). This evaluation compared metal

concentrations grouped by spatial unit to identify trends at the spatial unit scale. Temporal trends statistically compared the metal concentration of a given spatial unit with itself over time and with adjacent spatial units. The purpose of this analysis was to identify changes and trends in spatial unit concentrations that may have indicated the migration of metals. The following list summarizes the results of the spatial unit trend analysis.

- Most metals concentrations within the entire Litigation Area showed statistically significant differences over time but there were no consistent increasing or decreasing trends.
- In the remediated areas (Units 8, 12, 13, and 14), no metals concentrations showed significant differences over time, indicating that these units were not being recontaminated from neighboring unremediated areas or other sources.

2.3.3 Location-by-Location Scale

To evaluate location-by-location trends, Figures 22 through 37 and location-specific box plots (Attachment D1) were reviewed to visually identify potential increasing or decreasing trends.

Throughout most of the Litigation Area, the apparent trends identified in the location-by-location analysis were isolated and did not indicate a pattern of migration. No clusters of increasing or decreasing concentrations at the scale of a sampling location were found. Seldom did the trends occur for more than two metals at a particular location. It would be expected that if sediment or soil migration was occurring, it would have affected the concentrations of all or most of the metals in the same manner, and the concentrations would have risen or fallen as a group.

Zinc concentrations at each sampling location in Nichols Creek and the ponded wetland in RASS 3 are shown on Figure 34 for each year of the postremediation monitoring. Sampling locations were arranged geographically from the relatively uncontaminated locations above the Chemical and Pigment Company to the ponded wetland in RASS 3 and the culvert that empties into Lost Slough under the railroad trestle.

Concentrations of several metals were elevated in Unit 13, particularly zinc, with higher concentrations in the ponded wetland than the creek bed. Much of the sediment carried by Nichols Creek probably drops out of suspension in the ponded wetland, as evidenced by the gradual filling in of the wetland that had been observed during postremediation monitoring. Concentrations of metals in the ponded wetland in RASS 3 were evaluated over time, and results showed that no consistent pattern exists of increasing or decreasing concentrations over time. As a result, while the ponded wetland had higher concentrations than the creek bed, these concentrations have not increased significantly over the postremediation monitoring period.

Individual locations in Unit 13 (Nichols Creek and RASS 3 ponded wetland) seemed to display trends that may have had some correlation to the high concentrations of zinc in this area. One location on the upstream side of Chemical and Pigment Company property (R03SH189) had a decreasing zinc concentration, while several locations downstream of Chemical and Pigment Company property had increasing concentrations of zinc. These locations included R03SH185, R03SH283, R03SH281, R03SH280, and R03SH277. These trends suggest that zinc may still be migrating down Nichols Creek.

A strong spatial gradient occurred in metals concentrations in sediment in the main slough, with highest concentrations in Units 10 and 11 and much lower concentrations in Unit 9, which is closest to Suisun Bay. Zinc concentrations in sediment at each sampling location in Units 9, 10, and 11 for each year of the monitoring are shown on Figures 35 through 37; locations are displayed geographically with distance from Suisun Bay. Unit 11 (southwestern reach of the slough) has the highest concentrations of zinc in the Litigation Area. High concentrations of zinc in this reach of the slough may have been a result of historical spills in the 1960s and 1970s or they may have represented an area of continued deposition during tidal exchange and storm events. No samples were collected in this unit during preremediation monitoring. Unit 11 is a narrow, meandering slough that is in direct connection with the central reach of Lost Slough (Unit 10). Unit 10 had lower concentrations of zinc than did Unit 11; however, many of the sediment sampling locations had concentrations of zinc consistently above 1,000 mg/kg.

While these graphs show spatial and temporal variation in concentrations of zinc, no clear pattern exists that indicated consistent migration of zinc down the slough toward the bay during the postremediation monitoring. It is likely that contaminated sediments move back and forth within reaches of the slough during the daily tidal action.

A hot spot analysis was conducted as part of the BERA (Appendix G) to identify locations that have had exceptionally high concentrations of all of the six metals.

2.4 ATTAINMENT OF CLEANUP GOALS IN REMEDIATED AREAS

Preremediation soil sampling results from the active areas to be remediated are presented in Tables 2, 4, 6, and 8. Sample results collected from the active remediation areas immediately after the remediation were completed are presented in Tables 3, 5, 7, and 9. As indicated in the tables, the remediation effort was successful in significantly reducing metal concentrations in remediated areas. The tables also show that cleanup criteria were met in each active remediation area, except for RASS 3 where the SARAC cleanup value for zinc (2,512 mg/kg) was not always achieved.

3.0 SURFACE WATER CHEMISTRY

This section summarizes the results of surface water sampling conducted on an annual basis during postremediation monitoring. Surface water samples were collected at 30 locations during the preremediation monitoring described in the baseline conditions report (PRC 1994), and 29 of these locations were included in the postremediation monitoring program. During preremediation monitoring, unfiltered and filtered samples were collected at 30 locations and analyzed for total and dissolved metals, respectively. During post remediation monitoring, most samples were unfiltered; however, a subset of filtered samples was collected for special studies during year 4 and year 5 postremediation monitoring. Comparison of filtered with unfiltered sample results (dissolved versus total metals) are discussed in Appendices E and G, and are not repeated in this section. During year 1, postremediation monitoring surface water samples were collected at 26 locations. Monitoring was expanded to 134 locations during years 2, 3, and 4. For year 5, the number of surface water sampling locations was reduced from 134 to 88 locations to allow for additional filtered samples and other special studies.

Chemical concentrations in surface water samples were compared with ambient water quality criteria (AWQC) and with data from previous years to evaluate temporal trends. Concentrations were also compared between various sampling locations in the Litigation Area to evaluate spatial trends. Surface water metals results were compared with chronic and acute AWQC, as presented in Tables 10A and 10B. Although neither saltwater nor freshwater AWQCs were entirely appropriate because the majority of the Litigation Area surface water is brackish (a mixture of both fresh water and salt water), the lower of freshwater or saltwater AWQCs was used to provide a conservative benchmark value. Freshwater AWQCs used for comparison were adjusted for a site-specific water hardness of 400-milligrams/liter calcium carbonate.

3.1 PREREMEDIATION SURFACE WATER MONITORING RESULTS

The Navy collected surface water samples at 30 locations in 1991 to establish preremediation conditions at the Litigation Area (PRC 1994). Paired surface water samples were collected at each of the sediment and surface water sampling locations shown on Figure 11 and analyzed for total and dissolved metals.

As shown on the figure, no preremediation surface water samples were collected from the ditches or sloughs in the southwestern portion of RASS 1 (Spatial Units 5 and 11), which was not considered part of the monitoring program at the time. Attachment D2 includes the results of preremediation surface water samples grouped by spatial unit designations that were developed in the postremediation program. Preremediation metals concentrations in surface water were also summarized in comparison with chronic and acute AWQCs on six maps (Figures 38 through 43). These maps use a color code to indicate the

concentration (compared with AWQCs) at each location for each year of monitoring. The color code is as follows:

- Blue: Less than the chronic AWQC
- Green: Greater than or equal to the chronic AWQC and less than the acute AWQC
- Yellow: Greater than or equal to the acute AWQC and less than two times the acute AWQC
- Orange: Greater than or equal to two times the acute AWQC and less than four times the acute AWQC
- Red: greater than or equal to four times the acute AWQC

During preremediation monitoring, surface water samples were collected in ditches in Units 3 and 7 in the northern and central marsh, respectively. As tides rise, water enters the ditch system from Lost Slough and overflows the ditches to cover the marsh surface on high tides. Surface water samples were collected on outgoing tides when water moves back toward Lost Slough. Concentrations of total metals in unfiltered water samples from ditches vary dramatically, but are generally higher than water samples from other areas in the Litigation Area (Attachment D2).

Two surface water locations were sampled in Unit 3 during preremediation monitoring. Total copper and selenium concentrations exceeded chronic AWQCs at both locations. Each of the remaining metals exceeded chronic AWQCs at one location. Dissolved concentrations were lower, with copper exceeding the chronic AWQC at one location and selenium at both locations.

Surface water samples were collected at 10 locations in Unit 7 during preremediation monitoring. Average total metals concentrations in Unit 7 exceeded those in Unit 3 for every metal. Average total metal concentrations for arsenic, cadmium, copper, and zinc were the highest of any of the six spatial units sampled during preremediation monitoring.

Metals concentrations in Lost Slough were typically lower than ditches; however, many exceedances of chronic AWQC still occur, particularly for copper and zinc. In Unit 9, total copper and selenium concentrations exceeded chronic AWQCs in both of the two sampling locations; lead and zinc exceeded chronic AWQCs in one location. In Unit 10, total copper concentrations exceeded the chronic AWQC in each of the seven locations; zinc exceeded in six locations and selenium in one location. The relative pattern of dissolved metal concentrations in Lost Slough was similar to total metals but the concentrations were lower, with fewer concentrations exceeding AWQCs.

In Unit 13 (Nichols Creek), chronic AWQCs were exceeded frequently; particularly for copper, which exceeded the chronic AWQC for both total and dissolved metals at each of the three locations sampled.

Unit 15 is a nontidal wetland in RASS 4 that receives water from a small ephemeral creek. Of four preremediation samples collected during preremediation monitoring, total concentrations of metals detected above chronic AWQCs included arsenic (1), cadmium (1), copper (4), lead (4), selenium (2), and zinc (3).

3.2 POSTREMEDIATION SURFACE WATER MONITORING RESULTS

The Navy conducted 5 years of annual postremediation surface water monitoring. Figure 12 shows postremediation sampling locations and 16 spatial units. Attachment D2 includes the results of the pre- and postremediation surface water samples grouped by spatial unit. Average metals concentrations for each spatial unit are included in the table. Postremediation metals concentrations in surface water were also summarized in comparison with chronic and acute AWQCs on (Figures 38 through 43). Surface water sampling results for the eight spatial units with water samples were grouped into four areas for discussion: ditches (Units 3, 5, and 7), Lost Slough (Units 9, 10, and 11), Nichols Creek and pond (Unit 13), and RASS 4 wetland (Unit 15).

3.2.1 Surface Water Results in Ditches (Units 3, 5, and 7)

In Units 3, 5, and 7, approximately 22 ditches were identified running east to west and approximately 16 ditches were identified running north to south. The ditches are usually narrow, 1 to 2 feet wide, and covered with vegetation. The ditches vary in depth, but in general the distal ends (away from Lost Slough) appear to be filling with sediment and the proximal ends (closest to Lost Slough) appear to be getting deeper (TtEMI 1999). The east to west ditches often run parallel for long distances (up to 3,200 linear feet), with the smaller north to south ditches connecting them. As tides rise, water enters the ditch system from Lost Slough and overflows the ditches to cover the marsh surface on high tides. Surface water samples were collected on outgoing tides when water moves back toward Lost Slough.

Concentrations of total metals in unfiltered water samples from ditches varied dramatically, but were generally higher than water samples from other areas in the Litigation Area (Attachment D2). Chronic AWQCs were exceeded for each of the metals analyzed. Arsenic, copper, and zinc were detected frequently at concentrations exceeding chronic AWQCs, while cadmium, lead, and selenium were detected less frequently. For arsenic, approximately 30 percent of the samples collected from ditches

during postremediation monitoring exceeded chronic AWQCs. Copper and zinc was detected above AWQCs in almost half of the postremediation samples.

Postremediation average concentrations for each metal in the northern marsh ditches (Unit 3) were slightly lower than the southwestern marsh ditches (Unit 5), and significantly lower than those in the more contaminated central marsh ditches (Unit 7). This result generally correlated with the relative degree of soil and sediment contamination in these three units, which exhibited the same pattern.

3.2.2 Surface Water Results in Lost Slough (Units 9, 10, and 11)

Metals concentrations in Lost Slough were typically lower than ditches; however, chronic AWQCs were still frequently exceeded, particularly for copper and zinc. For copper, over a third of water samples collected from Lost Slough during postremediation monitoring exceeded the chronic AWQC. Zinc exceeded the chronic AWQC in approximately 40 percent of Lost Slough water samples.

Postremediation average concentrations for each metal in the northern reach of Lost Slough (Unit 9) were typically well below concentrations in the central reach of Lost Slough (Unit 10), and substantially lower than those in the southwestern reach of Lost Slough (Unit 11). As a result, general decrease occurred in metals toward the north, which was similar to the sediment contamination pattern. Sampling results varied significantly from year to year and from location to location, as would be expected since water in Lost Slough is always moving in response to tidal fluctuations.

3.2.3 Surface Water Results in Nichols Creek and Pond (Unit 13)

Similar to other units, copper and zinc were detected at concentrations frequently exceeding chronic AWQCs in Unit 13. For copper, over a third of the water samples collected from Unit 13 during postremediation monitoring exceeded the chronic AWQC. Zinc exceeded the chronic AWQC in over half of the Unit 13 samples. Concentrations exceeding AWQCs were detected in samples collected adjacent to the Chemical and Pigment Company facility.

3.2.4 Surface Water Results in RASS 4 Wetland (Unit 15)

Unit 15 is a nontidal pond and wetland that receives water from a small ephemeral creek that runs through a small residential neighborhood across Port Chicago Highway. Of the 20 samples collected during the five-year monitoring program, metals detected at concentrations exceeding chronic AWQCs included arsenic (7), cadmium (1), copper (10), lead (8), mercury (2), selenium (2), and zinc (9). It is noteworthy that mercury concentrations have remained relatively low. It does not appear that higher concentrations

of mercury, typically found in upgradient surface soil (Unit 14), are affecting water quality in this small wetland.

3.3 COMPARISON OF PREREMEDIATION AND POSTREMEDIATION SURFACE WATER RESULTS

Table 19 presents the average pre- and postremediation metal concentrations for each of the surface water sampling spatial units, except for Units 5 and 11, where no preremediation surface water samples were collected. The table shows that average postremediation concentrations were generally lower than preremediation concentrations. Concentrations are shaded where the postremediation average differed from the preremediation average by at least 20 percent.

In both the northern and central marsh ditch units (Unit 3 and 7), all of the postremediation total metals concentrations were lower. This result was the same for the northern reach of Lost Slough (Unit 9), except for zinc. In the central reach of Lost Slough (Unit 10), total concentrations of arsenic, copper, lead, and zinc were higher during postremediation monitoring. A similar result occurred for Nichols Creek and pond (Unit 13), where three of the same total metals (copper, lead, and zinc) were higher in postremediation monitoring. In the RASS 4 wetland (Unit 15), all of the postremediation total metals concentrations were lower, although not as dramatically as in the ditch units.

This comparison suggests that remediation activities resulted in a general decrease in metal concentrations in the ditches in Units 3 and 7, Lost Slough in Unit 9, and the wetland in Unit 15. In Lost Slough in Unit 10, four of the six average total metals concentrations were higher in postremediation monitoring. This result suggests that remediation activities did not reduce surface water metals concentration in this portion of the slough, and unremediated areas may act as a continuing source of metals to the slough. The similar pattern of higher average postremediation total metals concentrations in Nichols Creek and pond (Unit 13) suggests that a continuing source of metals to surface water exists in Unit 13; the source may be unremediated soil or the adjacent Chemical and Pigment Company facility.

As shown in Table 19, average dissolved metals concentrations were significantly lower than average total concentrations, indicating that a large proportion of surface water metal concentrations were a result of suspended solids in the water. The pattern for preremediation versus postremediation dissolved metals concentrations was similar to the total metals concentrations, indicating a general decrease following remediation activities, particularly in Units 3, 7, and 15. In Units 10 and 13, the higher postremediation total concentrations for arsenic, copper, lead, and zinc were not typically reflected in the dissolved

concentrations. This result suggests that if metals migration was occurring in these units, it was in the form of suspended sediments.

4.0 GROUNDWATER CHEMISTRY

Monitoring of the impact of contamination on groundwater was addressed in the "Tidal Influence Study and Postremediation Groundwater Monitoring Technical Memorandum" (PRC 1997b). The study demonstrated that metals concentrations in groundwater declined following soil remediation and groundwater discharge to sloughs and Suisun Bay appeared to be very limited. Groundwater sampling was dropped from the monitoring program after year 1; as a result, groundwater monitoring information was not included in this report since it was no longer part of annual monitoring efforts. Complete groundwater data and evaluation is provided in Appendix E.

5.0 VEGETATION SURVEYS

The following sections summarize vegetation data for pre- and postremediation monitoring in the Litigation Area.

5.1 PREREMEDIATION VEGETATION SURVEYS

The Navy conducted baseline vegetation surveys in 1992 before contamination remediation at the Litigation Area (H.T. Harvey and Associates 1992a). The survey areas included four RASSs, the upland reference area south of RASS 3, and the shoreline reference area west of the Litigation Area along Suisun Bay (Figure 2). The objectives of the study were to (1) establish baseline vegetation characterization of the entire study area, (2) provide detailed vegetation characterization of each primary sampling location within the RASSs and reference areas, (3) collect plant specimens for baseline contaminant bioaccumulation analysis, (4) characterize vegetation at salt marsh harvest mouse *(Reithrodontomys raviventris)* trapping locations to identify plant associations of potential importance to this endangered species, and (5) to survey the four special status plant species.

5.1.1 Methods

Vegetation was characterized by quantifying the existing plant cover at each chemistry sampling location in the four RASSs and two reference areas. Plant species, composition, percent cover, and plant height of component species comprised the primary characterization parameters. Vegetation was analyzed at 85 vegetation and small mammal characterization locations and at 525 individual small mammal trap sites within these characterization locations. The 85 characterization locations are circled in red on Figure 11.

Plant samples for heavy metal bioaccumulation analysis were also collected at vegetation monitoring locations, including whole plants (with roots). Coastal zones adjacent to Suisun Bay, the banks of Nichols' Creek, mosquito ditch perimeters, and intra-ditch areas were surveyed for the special status plant species listed below:

- Soft bird's-beak *(Cordylanthus mollis ssp. mollis)*: Federal Endangered; California Native Plant Society (CNPS) List 1B; California Rare
- Mason's lilaeopsis *(Lilaeopsis masonii*): Federal Species of Concern; CNPS List 1B; California Rare
- Delta tule pea *(Lathyrus jepsonii ssp. jepsonii*): Federal Species of Concern; CNPS List 1B; No State Listing
- Suisun Marsh aster *(Aster chilensis var. lentus)*: Federal Species of Concern; CNPS List 1B; No State Listing

Lastly, each RASS and reference area was delineated into areas of specific vegetation cover types by observing the spatial distribution of all plants present within a given area and by estimating the relative contribution of individual species to total percent cover within that area. A dominant (or two codominant) species was used to identify the delineated zone.

5.1.2 Results and Conclusions

RASSs 1 and 2 and the shoreline reference area were primarily tidally influenced salt marshes. Pickleweed *(Salicornia virginica)*, saltgrass *(Distichlis spicata)*, and peppergrass *(Lepidium latifolium)* were the dominant species at the vegetation characterization locations in RASS 1 and the shoreline reference area. Approximately one-half of the total area of RASS 2 was comprised of upland grasses and herbs, dominated by ripgut grass *(Bromus diandrus)*, peppergrass, and perennial ryegrass *(Lolium perenne)*. The remainder of RASS 2 was a tidally influenced salt marsh (closely bordering RASS 1) with saltgrass, pickleweed, and perennial ryegrass as the most abundant species (H.T. Harvey and Associates 1992a).

RASSs 3 and 4 and the upland reference area were primarily upland sites. RASS 3 sampling sites were dominated by mixed upland grasses, including oatgrass *(Avena fatua)*, ripgut grass, and perennial ryegrass. Ripgut grass and yellow-star thistle *(Centaurea solstitialis)* were the two most prominent species sampled in the RASS 4 characterization quadrants. The smaller area of emergent marsh vegetation in RASS 4 included cattail *(Typha latifolia*), common tule *(Scirpus acutus)*, and saltgrass and

pickleweed. The upland reference area was dominated by perennial ryegrass and Mediterranean barely *(Hordeum geniculatum)* (H.T. Harvey and Associates 1992a).

Delta tule pea was found at five locations along the eastern coastal section of the shoreline reference area. Soft bird's-beak populations were found at five locations in RASS 1. Two separate populations of Mason's lilaeopsis were found at the shoreline reference area, and one population, divided into three separate groups, was found in RASS 1 along the coast of Suisun Bay. Suisun Marsh aster populations were not located in the Litigation Area despite extensive searches made in suitable habitats.

Bioaccumulation results were summarized in the QEA (PRC 1997c), and were used in food-chain modeling to evaluate risk to higher-trophic-level receptors in the BERA (Appendix G).

5.2 POSTREMEDIATION VEGETATION STUDY

Five years of postremediation vegetation monitoring (1995 through 1999) were conducted at the Litigation Area. Comprehensive vegetation characterization was only conducted during the QEA; a vegetation community map of the Litigation Area was provided in that document (PRC 1997c). The extensive preremediation vegetation monitoring program was distilled down to two primary components: (1) special status plant species surveys and (2) revegetation monitoring. Postremediation monitoring was conducted in the same four RASSs as the preremediation baseline surveys. Vegetation characterization locations used for the preremediation surveys were not revisited in postremediation surveys. Instead, all of the RASSs and reference areas, including coastal zones adjacent to Suisun Bay, the banks of the central tidal slough, mosquito ditch perimeters and intra-ditch areas, were walked and visually inspected for the presence of special status plant species. Although the upland reference area remained the same, the shoreline reference area was replaced by the marsh reference area, established in the northwestern corner of RASS 1. Because of these differences in sampling design, pre- and postremediation monitoring was not directly comparable.

5.2.1 Special Status Plant Surveys

Special status plant surveys were conducted during year 1 and year 2 by H.T. Harvey and Associates, year 3 by Sugnet and Associates, and year 4 and year 5 by ECORP•Sugnet (formally Sugnet and Associates), and were reported in the annual monitoring reports (PRC 1996, 1997a; TtEMI 1998, 1999, 2000). In addition to the four special status plants identified in preremediation vegetation monitoring, marsh gumplant *(Grindelia stricta* variation *augustifolia)* (No Federal Listing; CNPS List 4; No State Listing) was also surveyed in year 5.

5.2.1.1 Methods

Prior to the field survey investigations, special status species were identified in the Litigation Area using the California Natural Diversity Data Base (CNDDB) (Rarefind II) to determine whether any special status plant species have been reported to occur within the "Honker Bay, California," and immediately adjacent to the "Vine Hill, California," 7.5-minute U.S. Geologic Survey topographic quadrangles. In addition to the CNDDB, *Inventory of Rare and Endangered Vascular Plants of California* (Skinner and Pavlik 1994), "Annual Report on the Status of California State Listed Threatened and Endangered Animals and Plants" (California Department of Fish and Game [CDFG] 1992), and "California Natural Diversity Data Base Special Plants List" (CDFG 1998) were reviewed to identify potential special status species in the Litigation Area. Confirmation of species identification involved the use of several taxonomic keys (Hickman 1993; Munz and Keck 1968; Mason 1957, Jepson 1925).

For the purposes of this report, the terms "aggregation" and "individual" are used to refer to special status species found in the Litigation Area. These terms are defined as follows:

- Aggregations: Clusters of special status plants found at single locations.
- Individuals: Individual special status plants found at the Litigation Area.

The actual numbers of individuals within each aggregation was determined by actual counts or by estimation (such as counting the number of individuals preset, assessing the typical phenology of individuals, and extrapolation of the population in the greater area).

5.2.1.2 Results and Conclusions

In postremediation monitoring, soft bird's-beak, Mason's lilaeopsis, delta tule pea, and Suisun Marsh aster were all identified within portions of RASS 1. Delta tule pea and soft bird's-beak were found within the marsh reference area, and Suisun Marsh aster was identified within the northwestern portions of RASS 3. None of the other RASSs or reference areas were found to support these or any other special status plants. Although special status species show considerable population fluctuation throughout the postremediation monitoring years 1 through 5, the numbers of aggregations have generally increased for most species.

The number of special status plant aggregations found over the 5 years of postremediation monitoring is shown on Figure 44. Figure 45 presents the total number of individual special status plants over the same 5-year period. It is important to note that delta tule pea counts made in years 1 and 2 have been excluded

from this figure, because this species was counted differently prior to year 3. Secondly, as mentioned below, only a subset of Suisun Marsh aster aggregations were surveyed in year 5. In order to normalize these data for this species on Figure 45, individual numbers for years 1 through 4 were provided only for those aggregations that were surveyed in the final year 5 subset.

Soft Bird's-beak

Soft bird's-beak has been present in RASS 1 since the 1991 preremediation surveys. During postremediation monitoring, aggregations of soft bird's-beak were identified at several locations within, and adjacent to, the revegetated portion of RASS 1, as well as in the northwestern portion of the site, including the marsh reference area. In year 5, soft bird's-beak was found throughout the RASS 1 marsh, with the highest densities in the northwestern corner. As shown on Figure 45, although the number of aggregations of soft bird's-beak increased in the Litigation Area (Figure 44), the total numbers of individuals decreased in years 4 and 5. The number of soft bird's-beak aggregations peaked in year 4; this peak could have been a result of natural variability and does not diminish the overall increase in soft bird's-beak aggregations over the past 5 years of postremediation monitoring.

Mason's Lilaeopsis

Although several aggregations of Mason's lilaeopsis were identified in year 1 and year 2, previous reports have concluded that all but two aggregations were misidentified because of their resemblance to three-ribbed arrow-grass *(Triglochin striata)* and low club-rush *(Scirpus cernuus)*, two species present in close proximity to Mason's lilaeopsis. The misidentified aggregations are not represented on Figure 44. Only two aggregations of Mason's lilaeopsis were considered unquestionable prior to year 3; these aggregations were approximately 1,500 feet northwest of the northeastern corner of RASS 1, immediately along Suisun Bay shoreline. It is likely that these aggregations were part of the same aggregation (one divided into three subgroups) that was identified in preremediation surveys because of their similar location. Only two new aggregations have been identified (in year 5) since the two confirmed in year 1. In conclusion, Mason's lilaeopsis is not present in significant numbers in the Litigation Area.

Delta Tule Pea

During preremediation surveys, delta tule pea was not found in the Litigation Area. However, in postremediation monitoring, delta tule pea was found at several locations along the coastal sections of RASS 1; along Lost Slough, which traverses the western portion of RASS 1; and in the marsh reference area. The delta tule pea population remained relatively stable throughout the past 5 years of

postremediation monitoring. The number of aggregations of delta tule pea peaked in year 5 (Figure 44), although individuals exhibited the highest numbers in year 4 (Figure 45). The year 5 decrease in individual plant numbers may be the result of natural annual population fluctuations and unfavorable climatic conditions experienced during the 1999 growing season and 1998 seed set. Overall, the delta tule pea has established and maintained a stable population in the Litigation Area since preremediation surveys.

Suisun Marsh Aster

Suisun Marsh aster was also not found during the 1991 preremediation surveys. In year 1, four aggregations were reported in the Litigation Area close to the edges of on-site water channels. Although, these aggregations were not observed in year 2, the year 3 survey reidentified the original four Suisun Marsh aster aggregations, and documented several additional aggregations throughout RASS 1. The year 4 and 5 surveys identified numerous additional aggregations distributed through RASSs 1 and 3 (Figure 44). Given the high number of Suisun Marsh aster aggregations identified in year 4, a subset of only 30 aggregations was selected for inspection in year 5. Additional aggregations of Suisun Marsh aster were not counted in year 5. As a result, the number of aggregations of Suisun Marsh aster reported for year 5 on Figure 44 is greatly underestimated. However, even with these aggregations excluded from the year 5 survey, the number of individuals of Suisun Marsh aster greatly increased in the Litigation Area (Figure 45). Its presence has greatly expanded in the Litigation Area since the preremediation survey.

Marsh Gumplant

Marsh gumplant was common along ditches and other densely vegetated portions of RASS 1. The population of marsh gumplant was not mapped during the year 5 investigations because of its abundance and wide distributions. Sugnet and Associates mapped the approximate locations of gumplant vegetation associations in year 3. This special status species seems to have a relatively stable population.

5.2.2 Revegetation Monitoring

Active revegetation was conducted in the Litigation Area in 1994 and 1995 for the remediated portions of RASSs 1, 2, and 4. RASS 3 was not revegetated but was reseeded and qualitatively evaluated. Postremediation revegetation monitoring was conducted by H. T. Harvey and Associates in year 1 and year 2, by Sugnet and Associates in year 3, and by ECORP•Sugnet in year 4 and year 5 to evaluate the success of the revegetation efforts and was reported in the annual monitoring reports (PRC 1996, 1997a;

TtEMI 1998, 1999, 2000). Monitoring success criteria and parameters for each of the specified RASS revegetation areas were established through review and input by regulatory and trustee agencies (H.T. Harvey and Associates 1989, 1992b, 1995). Specific RASS revegetation areas and success criteria are presented in the table below:

RASS	Revegetation Areas	5-Year Success Criteria
RASS 1	9-acre tidal marsh revegetation area	80 percent native plant cover
RASS 2	4-acre tidal marsh revegetation area	80 percent native plant cover
RASSs 1 and 2: Staging Area	1.4-acre coyote brush planting area	50 percent survival of coyote brush
RASS 3	6.9-acre wetland and upland natural area	Not applicable
RASS 4	2.5-acre wetland emergent marsh and coyote bush revegetation area	60 percent native plant cover and 60 percent survival of coyote brush

5.3.2.1 Methods

Plant associations included in the revegetation effort for each area are as follows:

- RASS 1: pickleweed marsh, lower transition marsh, emergent marsh, and upland refugial mound
- RASS 2: pickleweed marsh, alkaline upper marsh, and upper marsh
- RASSs 1 and 2 (staging area): coyote brush planting
- RASS 3: no vegetation associations
- RASS 4: wetland revegetation area and upland coyote brush planting

Revegetation maps for RASSs 1, 2, 3, and 4, and the RASSs 1 and 2 staging area are in Appendix D of the "After Remediation (Year 5) Remedial Action Monitoring Report" (TtEMI 2000).

Revegetation monitoring within each remediated area included a determination of average cover of selected species, an assessment of pickleweed (or dominant species) height at each sampling location, and an evaluation of frequency of species occurrence within each plant association in the revegetation areas. In RASS 1, vegetation composition comparisons were also made between the remediated area and the naturally occurring pickleweed area (pickleweed reference area) in the southwestern corner of RASS 1 (see Figure 2-1 in Appendix D of the year 5 monitoring report [TtEMI 2000]). In the RASSs 1 and 2 staging area and in RASS 4, coyote brush survival was determined by a count of the number of living coyote brush plants installed. In RASS 3, the percent of vegetation cover was recorded for groups of

dominant and codominant species. In wetland revegetation area of RASS 4, the line-incept method was used to assess percent cover. Lastly, soil moisture and chemistry values were measured for each area.

A total of 20 pickleweed experimental revegetation plots were randomly situated within RASS 1 and RASS 2 during 1995 to evaluate the effectiveness of different pickleweed planting techniques. Subplots were treated with one of four pickleweed vegetation techniques (plug planting, tube planting, seed application, or natural regeneration [control]).

RASS 1 Revegetation Success

Within RASS 1, three of the four habitat associations have met the final year 5 success criterion of 80 percent native plant species cover by year 5 (Table 20). These habitat associations are the pickleweed marsh, the lower transitional marsh, and the emergent marsh habitat associations. The refugial mound habitat association had not met the final year 5 success criterion because of the presence of nonnative grass species such as Mediterranean barley, perennial ryegrass, and annual rabbit-foot grass *(Polypogon monspeliensis)*. The drier conditions on the mounds favored the growth of these invasive species. The weighted average percent cover of native species for all four associations (79.5 percent) within RASS 1, however, is very close to the final year 5 success criterion of 80 percent native species cover.

The pickleweed marsh within the remediated area differed slightly from the reference pickleweed marsh site. In year 5, species diversity was higher within the remediated area; however, only native species were present in the reference area. This difference may be an artifact of the design of the remediated marsh, in terms of specific elevation and hydrology. Pickleweed dominated both the reference and remediated areas, with cover values of 50.8 and 21.5 percent (TtEMI 2000).

RASS 2 Revegetation Success

None of the habitat associations in RASS 2 has met the final year 5 success criterion of 80 percent native species cover (Table 20). Native species cover values for the pickleweed marsh, alkaline upper marsh, and upper marsh associations were 70.3, 78.8, and 25.1 percent. It is likely that the elevation and resulting hydrology of this area did not promote the establishment of salt marsh habitat, and that the plant species selected do not thrive in the site hydrologic conditions. The 1998 to 1999 season experienced below-average rainfall, which may have been responsible, in part, for the changed species compositions since 1998.

RASS 3 Revegetation Success

The vegetative cover within the RASS 3 revegetation area is progressing and maturing favorably. Various emergent wetland vegetation types colonized and dominated the wetter portions of the site in the RASS 3 pond. The eastern portion of the remediation area is drier and continues to be dominated by nonnative grasses. Since no native plants were planted in the remediation zone (other than hydroseeding), no explicit success criteria were identified.

RASS 4 Revegetation Success

The RASS 4 wetland revegetation area is a brackish water emergent marsh, which is being influenced by fresh water from direct rainfall and runoff from adjacent urban development. The percent cover of native wetland species during the year 5 monitoring season was 99.4 percent as compared with 79.9, 96.3, and 85.1 percent in years 2, 3, and 4 (Table 20). The wetland habitat restoration consistently exceeded the 60 percent final success criterion for years 1 through 5. On the other hand, the percentage of survival of coyote brush in the upland planting areas of RASS 4 was 55 percent in year 5, which was slightly higher than the 51 percent documented in year 4. Still, the coyote brush population has not met the final success criterion of 60 percent coyote brush survival. Coyote brush was planted in subsurface soil after the contaminated topsoil was removed. Reduced topsoil amounts may have contributed to the high mortality of coyote brush at this site. Competition with weedy species also may have reduced the survival of this species. An unidentified vine species, possibly vetch (*Vicia* species), was observed over many dead coyote brush shrubs during the year 4 survey. In addition, yellow star thistle was observed throughout the upland planting area during both the year 4 and year 5 surveys.

RASSs 1 and 2 Staging Area Revegetation Success

The RASSs 1 and 2 staging area is an upland area between RASSs 1 and 2 where construction equipment was staged during the remediation activities in 1994 and 1995. Coyote brush was also planted within the RASSs 1 and 2 staging area after remediation activities were completed. This planting area has met the 50 percent success criterion for coyote brush survival (Table 20).

Pickleweed Planting Techniques

The effectiveness of different pickleweed marsh restoration techniques used in RASSs 1 and 2 were statistically compared. The analysis indicated that no significant differences existed in pickleweed cover and height as a result of the various planting techniques. Nor were there any significant differences in

pickleweed height and cover between RASS 1 and RASS 2, except for the case of seed plots, in which pickleweed cover was slightly lower in RASS 2. This minor statistical difference may have been a result of small sample size.

5.3.2.3 Conclusions

Overall, revegetation efforts were successful within RASS 1, the RASSs 1 and 2 staging area, RASS 3, and the RASS 4 wetland. If the RASS 1 marsh is allowed to develop naturally and without disturbance over the next few years, it is expected to closely resemble nearby areas.

None of the habitat associations in RASS 2 has met the year 5 success criterion of 80 percent native species cover. However, with the exception of the upper marsh association, it appears likely that the success criterion will be met in the near future. Native species cover within the pickleweed marsh and the upper alkaline marsh associations have been increasing since monitoring was initiated in 1995. However, active management or recountouring may need to be implemented if 80 percent native species cover is the desired condition of the RASS 2 upper marsh. Nonnative species removal and native plant application in the upper marsh areas would be labor intensive, because the predominance of nonnative species in the surrounding area provides an unlimited supply of nonnative seeds. Another way to increase native plant species cover in the upper marsh association would be to increase the tidal influence. The area could be recountoured by excavating to a depth or elevation of the surrounding alkaline upper marsh or pickleweed marsh. Alternatively, additional tidal waters might be introduced into this area through the construction of a ditch, which can be tied into an existing ditch north of RASS 2. These recommendations should be considered in light of the high concentrations of contaminants that may be mobilized by any change in tidal action.

The RASS 4 coyote brush planting survival could likely increase with some form of weed control, which may reduce competition and potentially increase the percent survival and vigor.

In general, an occasional reconnaissance-level survey is recommended to ensure that the Litigation Area wetland and upland revegetation areas maintain their present conditions.

6.0 SMALL MAMMAL SURVEYS

The first small mammal trapping surveys were conducted in the Litigation Area before remediation of contaminated soil in 1991 (H.T. Harvey and Associates 1992c). Additional small mammal surveys were then conducted from 1995 through 1999 as part of a 5-year post remediation monitoring effort

(TtEMI 2000). ECORP Consulting, Inc. conducted the year 5 small mammal surveys; the year 4 survey was conducted by Garcia and Associates (TtEMI 1999), and all prior surveys (year 1, year 2, and year 3) were conducted by H.T. Harvey and Associates (PRC 1996, 1997a; TtEMI 1998). All small mammal surveys placed emphasis on monitoring for the presence of the salt marsh harvest mouse *(Reithrodontomys raviventris)*, an endangered species known to inhabit the saline emergent wetlands of the Litigation Area (H.T. Harvey and Associates 1985).

The population and distribution of the salt marsh harvest mouse around San Francisco Bay have declined substantially, primarily as a result of development of tidal salt marshes for agriculture, salt production, and urban growth. The loss of habitat and declining condition of the species' population has warranted listing the salt marsh harvest mouse under the State and Federal Endangered Species Act. Historical and current loss or degradation of saline tidal wetlands has reduced the dense stands of pickleweed *(Salicornia virginica)* on which the salt marsh harvest mouse is dependent (CALFED Bay Delta Program 1999).

Small mammal surveys were conducted in all four RASSs and reference areas. The objectives of preremediation surveys were to (1) determine distribution, abundance, and habitat utilization by salt marsh harvest mice; and (2) collect specimens of other species of rodents (including species closely related to the salt marsh harvest mouse that are not special status species) for contaminant bioaccumulation and histopathological analysis. Objectives identified in the five-year postremediation monitoring include (1) characterize the small mammal community across the salt marsh and the upland areas, including distribution and habitat utilization by the salt marsh harvest mouse; and (2) determine the recolonization patterns of the small mammal community in the active remediation areas within the marsh (RASSs 1 and 2). Postremediation monitoring did not include bioaccumulation measures, except for analysis of mercury in rodents in RASS 4 during the year 4 monitoring.

6.1 METHODS

Small mammals that have been trapped in the Litigation Area include the salt marsh harvest mouse, the western harvest mouse *(Reithrodontomys megalotis)*, unidentified harvest mice, the California vole *(Microtus californicus)*, the house mouse *(Mus musculus)*, the deer mouse *(Peromyscus maniculatus)*, and the Norway rat *(Rattus norvegicus)*. Shrews have also been occasionally trapped but were not the focus of the monitoring.

In the preremediation (1991) surveys, trapping took place in 30 locations in RASS 1 and in 15 locations (each) in RASS 2, RASS 3, and RASS 4. Four and six locations were also sampled in the upland and

shoreline reference areas. The 85 small mammal characterization locations are circled in red on Figure 11. In the year 1 postremediation survey, small mammal sampling transects were established by H.T. Harvey and Associates (1992c), which replaced the 85 sampling locations used during the preremediation surveys. Ten transects were established in RASS 1, four in RASS 3, and four in RASS 4 (Figure 21). Although trapping methodology was similar for pre- and postremediation surveys, the number of trap nights was much larger in preremediation surveys (3,290 traps nights, as compared with 2,480 trap nights in postremediation surveys), and the spatial array of traps were different, making quantitative comparisons between the two survey periods difficult.

Five additional trapping grids were established during the year 2 survey and were sampled each following year (Figure 21). The grids were added to the trapping program to obtain more data about the salt marsh harvest mouse use and recolonization of the remediated areas (H.T. Harvey and Associates 1996c). The five grid sites were selected based on a combination of habitat type attributes (for example, contamination level, remediation status, and vegetative cover) and constraints (for example, presence of ditches and sloughs precluded trapping in some areas). Two grids were established within the active remediation area of RASS 1, one was established in the active remediation area in RASS 2, one was established in a relatively uncontaminated section of marsh, and one was established in a moderately contaminated section of marsh.

For all surveys, small mammals were captured using the trap and release method. Sherman live traps were baited with rolled oats, ground walnuts, and birdseed, and supplied with polyester bedding material. Traps were checked each morning at sunrise, closed during the day, and opened again each evening.

All captures were fur clipped to distinguish recaptures and were identified to species, sex, and age. Reproductive status was also recorded. All salt marsh harvest mice were identified using Shellhammer's methodology (1984). This method uses close examinations of the tails of the salt marsh harvest mouse and the closely related western harvest mouse, which tend to show some differences between the species.

Vegetation was also characterized at each survey trap location. Percent cover for each species, as well as bare ground, thatch, and litter, was estimated visually and recorded.

During preremediation surveys, house mice, deer mice, and California voles were collected from the trapping locations and sacrificed for later histopathological and toxicological analysis. These data have been used in the food-chain modeling component of the BERA (Appendix G).

6.2 RESULTS AND CONCLUSIONS

Results of the small mammal trapping are presented in the following sections.

6.2.1 Preremediation

In 1992, a relatively large population of salt marsh harvest mice was present in the wetland. During the 3,290 trap nights, a total of 241 harvest mice were captured: 200 salt marsh harvest mice, 26 western harvest mice, and 15 unidentified species. Salt marsh harvest mice were also captured in tidal regions of RASS 1 and the shoreline reference area. Western harvest mice were captured in upland habitats of RASS 3 and RASS 4.

Salt marsh harvest mouse captures were generally highest in areas with relatively high percent cover values of pickleweed. However, the species was also trapped in areas with relatively high cover values for saltgrass, peppergrass *(Lepidium latifolium*), and Baltic rush *(Juncus balticus)*.

6.2.2 Postremediation

Based on 2,480 trap nights, the total number of small mammals captured during the year 5 survey was greater than any previous survey year for the postremediation monitoring period (Figure 46). Similarly, the number of salt marsh harvest mice captured in year 5 was also the largest for the postremediation monitoring period except for year 2. However, the number of salt marsh harvest mice and other small mammals captured has varied greatly over the 5 years of post remediation monitoring. Because of this variability, there is no clear population trend.

Based on vegetation characterization of small mammal trap locations, the preferred vegetation for harvest mice is pickleweed, saltgrass *(Distichilis spicata)*, and Baltic rush. Vegetation associations for harvest mice are similar to the preremediation findings. In both pre- and postremediation surveys, the salt marsh harvest mouse was not found in upland habitat, which is dominated by nonnative species such as perennial ryegrass *(Lolium perenne)* and yellow-star thistle *(Centaurea solstitialis)*.

Although no differences in small mammal numbers were generally noted between remediated grids and unremediated grids, salt marsh harvest mice captures did outnumber western harvest mice captures for remediated grids in years 2 through 5. Salt marsh harvest mice are actively recolonizing the pickleweed habitat in the remediated areas of RASSs 1and 2 (TtEMI 1999, 2000).

7.0 BLACK RAIL SURVEYS

Prior to contamination remediation, baseline surveys were conducted in 1991 for the California Black Rail *(Laterallus jamaicensis coturniculus)* and California Clapper Rail *(Rallus longirostris obsoletus)* in the Litigation Area by H.T. Harvey and Associates (1992d). Annual monitoring events took place after remediation to evaluate trends in rail densities over the five years (1995 through 1999). All rail surveys were conducted by H.T. Harvey and Associates and reported in the annual monitoring reports (PRC 1996, 1997a; TtEMI 1998, 1999, 2000). Clapper rail surveys were discontinued in year 4 because only two individuals were detected in year 1 and one individual in year 2. Clapper rails prefer salt marsh with channels and stands of Pacific cordgrass *(Spartina foliosa)*, which are not found in the Litigation Area. Clapper rails that were detected are believed to represent transitory, unmated males moving through the area and not members of any resident population at the site.

The California Black Rail is listed as a State Threatened Species in 1971 by the CDFG, and is a Federal Candidate Species, Category 1, for listing as Threatened or Endangered by the U.S. Fish and Wildlife Service (1991). The Black Rail is also listed as a California Fully Protected Species (Laudenslayer and others 1991). California Black Rails are mostly restricted to the tidal marshes of San Francisco Bay, and a relatively dense population occurs at NWSSBD Concord (Evens and others 1991).

7.1 METHODS

California Black Rail surveys were conducted in the 81.2-hectare tidal marsh within RASS 1 and RASS 2. During the 1991 preremediation baseline surveys, four 450-meter transects were delineated and used therein for all annual monitoring events (Figure 21). Each transect contained 10 census stations located at 50-meter intervals. Transects were walked by two surveyors twice a day (0600 to 0900 pacific standard time [PST] and 1900 to 2100 PST) for 10 days during the Black Rail breeding season (late April or early May). Weather conditions, including wind speed and direction, air temperature, and cloud cover, were recorded at the beginning of each survey.

Black Rail “kik-kik-kerr” and “gurrr” calls (recorded at NWSSBD Concord in 1985) were broadcast from a Realistic cassette player (Model SCP-29) through a Realistic Number 4-1303 stereo-amplified speaker system at each station for 5 minutes, with a 6-second sequence of calls repeated once per minute. When a Black Rail responded with a call, data, including time, station number, type of call, compass bearing, and estimated distance to the calling bird, were recorded.

During the preremediation surveys, rail detections were mapped by plotting their approximate location by angle and distance estimated during the survey on a 1:200 scale topographic map of the survey area. Polygons were drawn around detections that were assumed to have originated from the same bird. Each detection polygon represented a single individual, not a pair. Results represent a minimum estimate. No multiple regression or other statistical analyses were calculated for preremediation population numbers.

In postremediation surveys, the density of Black Rail populations at the Litigation Area was calculated. Only male calls were used for population estimates, because past research has shown that male detections are more consistent than female detections (Legare 1996). California Black Rails are apparently monogamous, and past research has shown a 1:1 sex ratio (Flores and Eddleman 1993; Eddleman and others 1994). Therefore, estimates of population densities were determined by doubling the value obtained for male abundance.

Using the program STATA (STATA Corporation 1995), multiple regression analyses were used to examine the relationship between temporal and environmental variables and detection probability for years 1, 2, 4, and 5. Because many environmental variables (such as moon phase, tide height at time of survey, time from last high and low tides, and height of last low and high tide) were not recorded in year 3, statistical analyses were not conducted for that year.

7.2 RESULTS AND CONCLUSIONS

Statistical analyses indicated a significant increase in rail numbers during the five-year period of postremediation monitoring. The best estimate of Black Rails at the Litigation Area in the year 5 monitoring event was 120 birds (60 males) (TtEMI 2000). This estimate was higher than previous estimates: 66, 64, 68, and 96 for year 1 through year 4 (Figure 47). The year 5 estimate also represented a 6-fold increase in the number of Black Rails since the 1991 preremediation survey, when approximately 17 birds were estimated to reside in the marsh (H.T. Harvey and Associates 1992d). Black Rail densities have increased from 0.407, 0.397, 0.414, 0.589, and 0.738 male rails per hectare for years 1 through 5 (Figure 47) (TtEMI 2000). Black Rail density was not measured during the preremediation survey. The total Black Rail estimates from previous years have been altered to account for late breeding season counts. These are minimum estimates because it is likely that less than 100 percent of the males responded during each survey (Legare 1996).

Based on the findings of Legare (1996), approximately 20 percent of all calls heard for Black Rails were expected to be those of females. This assumption is consistent with the proportion of female responses

heard at the Litigation Area in years 4 and 5, which was also approximately 20 percent (TtEMI 1999, 2000).

The Black Rail population increase was primarily related to the increased numbers of rails adjacent to and within the remediated area in year 5, and a dramatic increase in rail numbers in the southern portion of the tidal marsh (TtEMI 2000). Year 5 was the first year in which Black Rails were detected in the remediated area. These detections occurred within stands of bulrush that have recently invaded a few meters inside the pickleweed-dominated *(Salicornia virginica)* remediation area. The increase in Black Rail densities is likely a reflection of increased suitable rail habitat, such as cattails and bulrush (*Typha* and *Scirpus*, respectively). An increase in soggy areas or areas of standing water correlated with the portions of the marsh showing the greatest increase in numbers of Black Rails as well. No association was apparent between locations where Black Rails were detected and mosquito ditches, indicating that Black Rails are not likely to depend on this habitat feature.

8.0 EVALUATION OF EFFECTIVENESS OF THE MONITORING PROGRAM

The success of the monitoring program at meeting objectives and the use of long-term monitoring as part of the remedy for monitoring contaminants left in place were evaluated for the five-year review.

8.1 EVALUATION OF SUCCESS AT MEETING MONITORING OBJECTIVES

The monitoring objectives set forth in the WES monitoring plan and the subsequent revised versions were very general and contained no specific criteria to trigger additional monitoring or further remedial actions. Although the monitoring program has not addressed every issue of concern at the site, data collected during the five-year monitoring program have been sufficient to fulfill the monitoring objectives. In addition to fulfilling the monitoring objectives, the five-year monitoring program has provided data that will focus future efforts at the site, whether those efforts are additional remediation or future monitoring. Success at meeting monitoring objectives is described below:

- **Objective 1 (collect data that will assist in evaluating long-term changes in site conditions):** was accomplished by collecting chemical and ecological data in a consistent manner over a 5-year period. Statistical power analyses were used to determine the appropriate number of samples from each spatial unit to allow detection of concentration changes within, or between, units with a quantifiable level of certainty. Both statistical and graphical evaluations were used to identify changes or trends in concentrations at the scale of the spatial unit. Ecological surveys were conducted annually in a consistent manner to evaluate use of the site by special status species and to monitor the success of restoration efforts.

- **Objective 2 (evaluate potential contaminant migration to Suisun Bay):** was accomplished by collecting soil, sediment, and surface water samples in contact with Suisun Bay through a network of ditches and sloughs in a consistent manner over a 5-year period and by conducting special studies to evaluate potential migration during storm events and the net flux of dissolved metals and suspended sediment during incoming and outgoing tides. These studies showed little migration of contaminants to the Bay, but did indicate potential uncontrolled migration within ditches and sloughs in southern RASS 1.

- **Objective 3 (determine if the remediated areas become recontaminated, and if so, the extent of recontamination and potential sources):** was accomplished by collecting soil, sediment, and surface water samples in remediated areas in a consistent manner over a 5-year period. These data were statistically and graphically evaluated to determine that remediated areas in RASSs 1, 2, and 4 are not becoming recontaminated. Potential sources were identified for suspected recontamination in Unit 13 (erosion of Nichols Creek and upgradient neighboring sources).

- **Objective 4 (evaluate contaminant migration in unremediated areas):** was accomplished by collecting soil, sediment, and surface water samples throughout unremediated areas in a consistent manner over a 5-year period. These data were statistically and graphically evaluated to show that little change has occurred in concentrations in unremediated spatial units.

- **Objective 5 (monitor the overall habitat quality of the site, including the success of the restoration efforts and use of the site by special status plants and animals):** was accomplished by conducting surveys and vegetation mapping throughout the Litigation Area and within the areas disturbed by remediation efforts. Results of revegetation surveys evaluated in comparison with specific success criteria indicated that most revegetation efforts were successful; however, there were a few exceptions. No specific goals were set as a measure of habitat quality, but surveys indicate the continued presence and use of the site by special status plants and animals; most populations of special status species were stable or increased over the 5 years of monitoring.

- **Objective 6 (determine if the groundwater is impacted by contamination):** was accomplished by evaluating pre- and postremediation monitoring well samples, as described in the "Tidal Influence Study and Post-Remediation Groundwater Monitoring Technical Memorandum" (PRC 1997b). Some groundwater contamination is present at the site; however, groundwater is moving very slowly and is not likely to impact Suisun Bay. Some off-site sources of groundwater contamination may be impacting the site.

8.2 EVALUATION OF EFFECTIVENESS OF THE MONITORING PROGRAM AS PART OF THE REMEDY

The intensive five-year post remediation monitoring program met the requirements of the remedial action plan and record of decision and adequately fulfilled the general objectives of the monitoring plan; however, this is not to say that the monitoring program was completely effective at addressing all concerns about the site.

The monitoring program was focused on sampling for chemicals and addressing concerns about migration of contaminants; to a great extent the chemical monitoring effort was successful at addressing these concerns. The chemical monitoring program was designed without the knowledge that exists today about extent of contamination, potential for migration, and high degree of variability in chemical concentrations both laterally around sampling locations and vertically within the upper 6 inches.

The monitoring program was developed before risk assessment guidance became available, and the focus of the ecological monitoring was not to address risk-oriented questions. Ecological monitoring was not intended or designed to measure any specific effect of metals contamination on populations of plants or animals in the Litigation Area. Annual monitoring on the scale that was conducted at the Litigation Area was also not sufficient to detect population changes in species and their causes. Ecological monitoring was successful in monitoring ecological conditions at the site, evaluating the recovery of active areas from the physical damage that incurred during the remediation effort, and tracking the ongoing presence of special status species.

Finally, the monitoring program was designed before the advent of the data quality objective (DQO) process, and therefore would not meet today's standards for DQOs.

8.3 CONCLUSIONS AND RECOMMENDATIONS ON FUTURE MONITORING

With 5 years of post remediation monitoring now completed, sufficient monitoring information has been collected to evaluate the effectiveness of the program and to focus any future monitoring efforts. Any future monitoring program that is conducted at the site should consider the following recommendations:

- Any future monitoring should be developed based on the conclusions of the five-year periodic review assessment and input from the Navy, regulatory and trustee agencies, and interested parties.
- Any future monitoring should be designed to address specific objectives and answer specific questions rather than the general objectives of the current program.
- The DQO process should be used to focus future monitoring objectives.
- Any future monitoring should be very focused on smaller parts of the site, where significant risk or continued migration is suspected, to make best use of limited resources.
- Any future monitoring should include more specific temporal boundaries to (1) limit the scope and length of monitoring efforts, (2) provide specific trigger levels for additional action, and (3) establish exit criteria for cessation of monitoring.

- Any future monitoring should be closely tied to risk-based questions and questions about contaminant migration.

- Any future monitoring should take into account the observed variability in lateral and vertical distribution of contaminants.

- Any future monitoring should be closely tied to specific trigger levels for any contingency actions such as additional remediation or revision of monitoring frequency.

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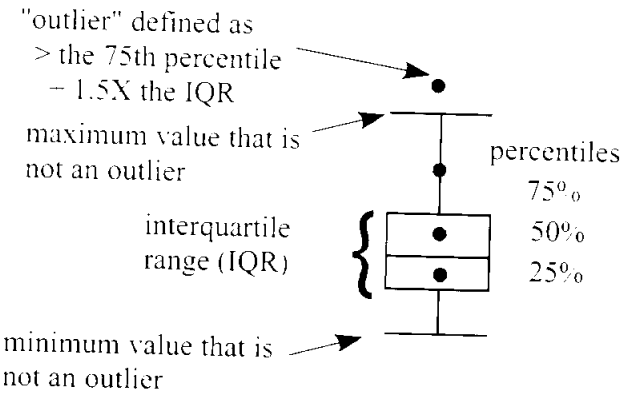
ATTACHMENT D1

POSTREMEDIATION METALS CONCENTRATIONS IN SOIL AND SEDIMENT

(54 Pages)

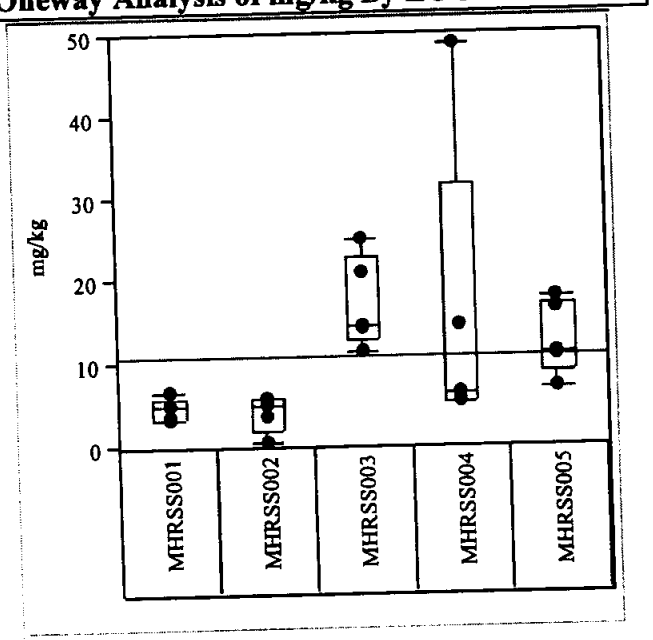
Key for Outlier Box Plots



shaded line through center of each plot is the grand mean across all locations

Spatial Unit 1, ARSENIC

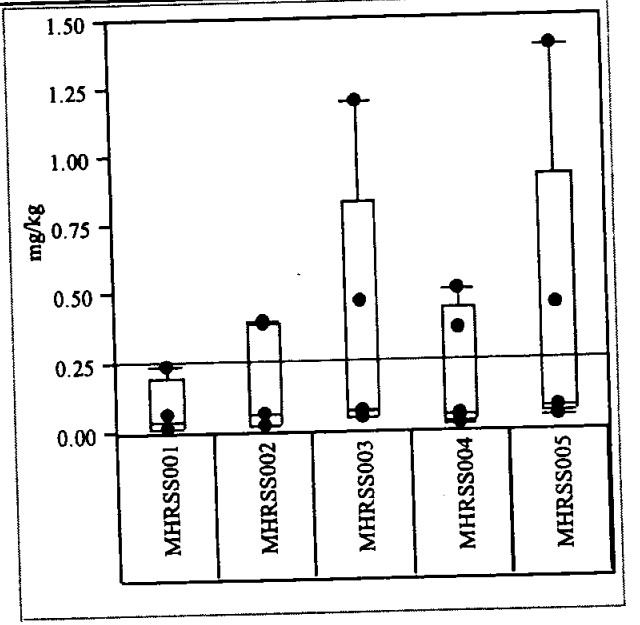
Oneway Analysis of mg/kg By LOCATION



LOCATION	Round				
MHRSS001	5.10	4.90	6.60	3.40	3.50
MHRSS002	4.90	5.80	5.60	1.10	3.50
MHRSS003	14.50	20.80	24.90	11.50	14.30
MHRSS004	5.60	6.40	14.50	48.90	5.20
MHRSS005	11.00	16.30	6.90	17.80	10.90

Spatial Unit 1, CADMIUM

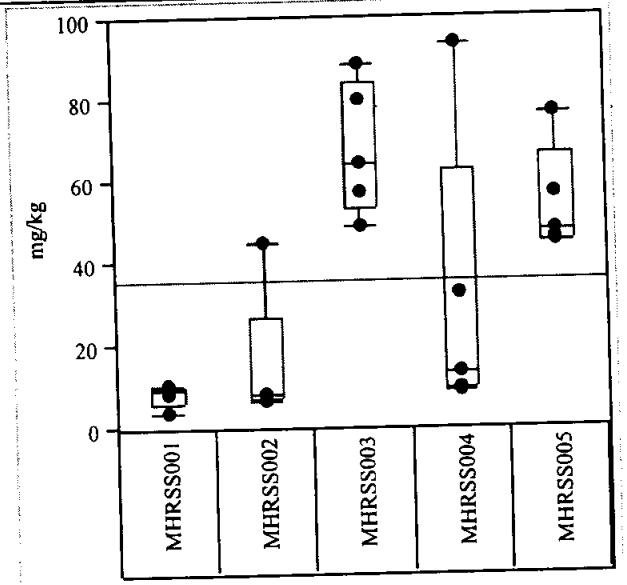
Oneway Analysis of mg/kg By LOCATION



LOCATION	Round				
MHRSS001		0.24	0.02	0.02	0.07
MHRSS002	0.03	0.39	0.03	0.40	0.07
MHRSS003	0.05	1.20	0.08	0.06	0.47
MHRSS004	0.03	0.37	0.05	0.06	0.51
MHRSS005	0.09	1.40	0.05	0.08	0.45

Spatial Unit 1, COPPER

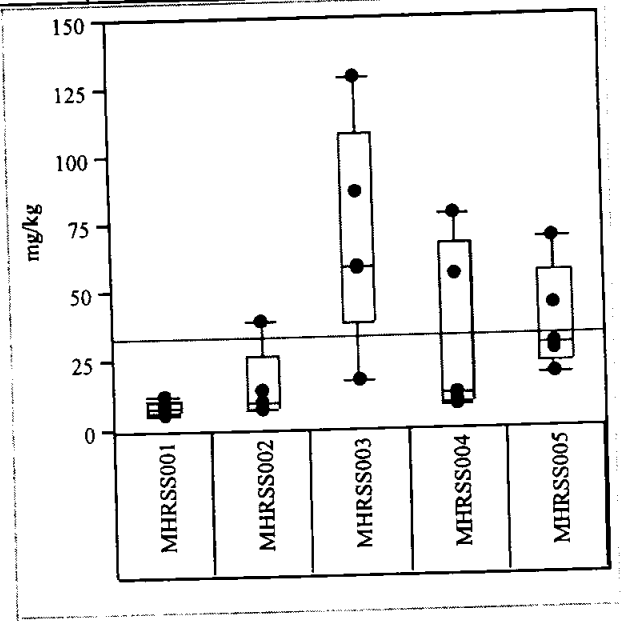
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
MHRSS001	9.70	10.60	8.10	9.90	3.85
MHRSS002	8.40	6.70	8.30	45.10	8.10
MHRSS003	57.40	80.10	88.70	48.90	64.40
MHRSS004	9.70	9.00	32.00	93.90	13.20
MHRSS005	44.90	47.90	45.40	76.40	56.80

Spatial Unit 1, LEAD

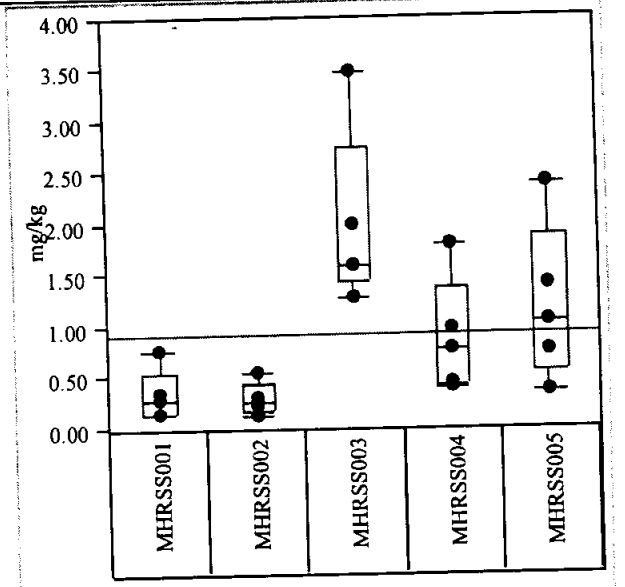
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
MHRSS001	7.50	9.50	8.60	12.10	6.00
MHRSS002	14.10	9.60	7.20	39.50	7.50
MHRSS003	58.10	87.00	129.00	17.80	58.80
MHRSS004	8.50	9.60	56.20	78.20	12.30
MHRSS005	29.90	19.40	27.80	69.40	44.30

Spatial Unit 1, SELENIUM

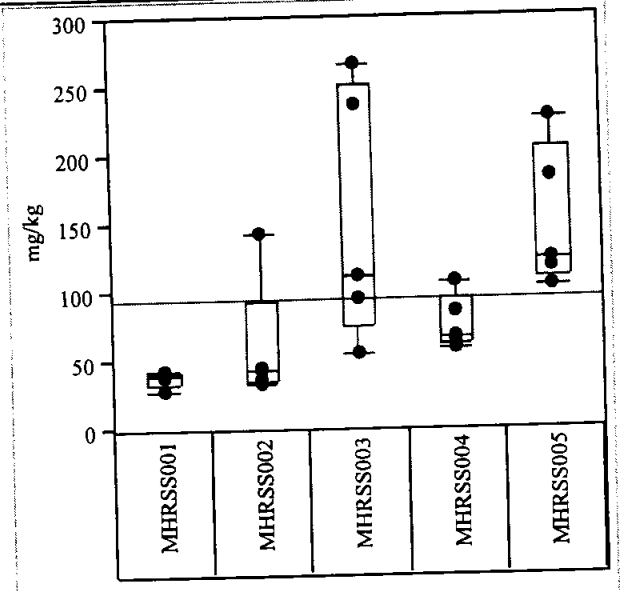
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
MHRSS001	0.29	0.77	0.17	0.17	0.35
MHRSS002	0.32	0.27	0.23	0.55	0.14
MHRSS003	1.60	2.00	3.50	1.60	1.30
MHRSS004	0.45	0.78	0.97	1.80	0.41
MHRSS005	1.05	0.75	0.36	1.40	2.40

Spatial Unit 1, ZINC

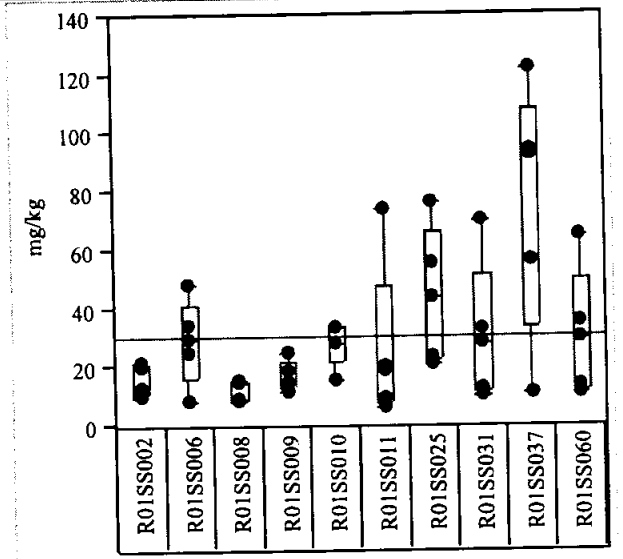
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
MHRSS001	38.50	40.90	43.20	39.70	27.80
MHRSS002	43.70	36.40	44.70	143.00	33.40
MHRSS003	111.00	237.00	267.00	54.30	95.00
MHRSS004	58.30	63.70	106.00	84.20	66.40
MHRSS005	104.00	184.00	116.00	226.00	123.00

Spatial Unit 2, ARSENIC

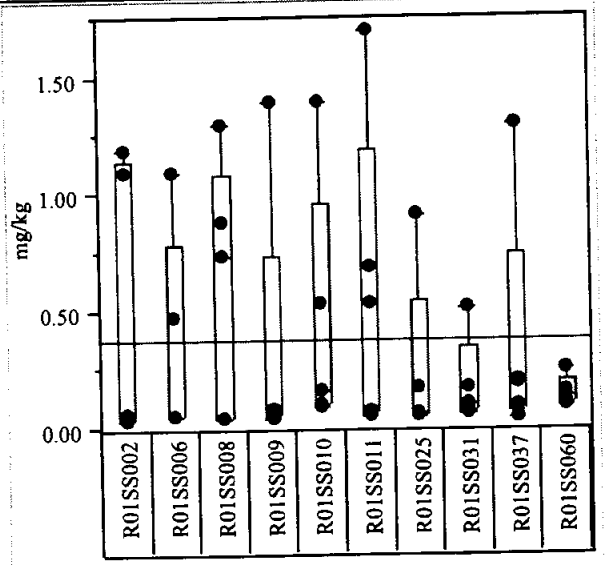
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS002	20.20	13.40	21.90	11.80	9.80
R01SS006	34.00	29.30	47.90	8.60	24.70
R01SS008	9.00	14.80	15.30	8.70	9.60
R01SS009	24.70	18.50	12.00	14.90	14.40
R01SS010	33.10	28.10	33.10	15.40	28.30
R01SS011	73.60	18.80	20.60	6.50	9.70
R01SS025	75.90	23.50	20.90	55.60	43.70
R01SS031	70.10	32.60	28.10	12.40	10.30
R01SS037	11.10	56.10	122.00	92.90	94.40
R01SS060	35.10	13.40	64.50	29.40	10.70

Spatial Unit 2, CADMIUM

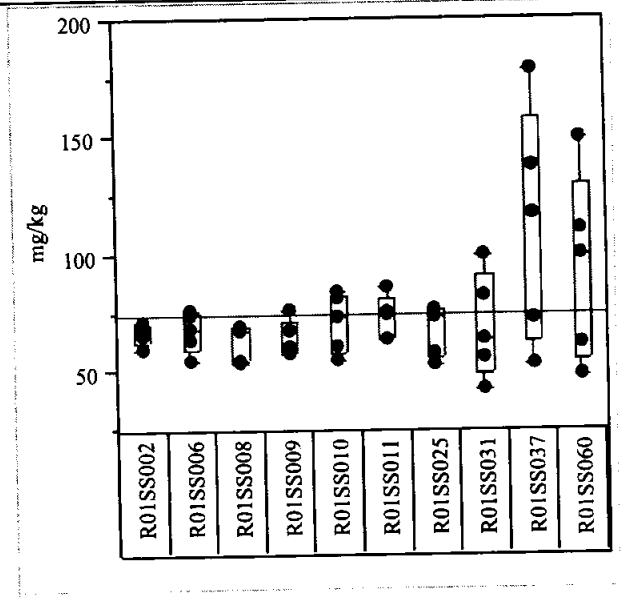
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS002	0.05	0.07	0.04	1.20	1.10
R01SS006	0.06	0.06	0.06	0.48	1.10
R01SS008	0.05	1.30	0.05	0.88	0.74
R01SS009	0.07	1.40	0.09	0.05	0.07
R01SS010	0.10	0.17	0.11	0.53	1.40
R01SS011	0.08	1.70	0.06	0.69	0.53
R01SS025	0.07	0.91	0.06	0.06	0.18
R01SS031	0.09	0.11	0.07	0.52	0.18
R01SS037	0.10	0.21	0.05	1.30	0.19
R01SS060	0.14	0.16	0.10	0.25	0.12

Spatial Unit 2, COPPER

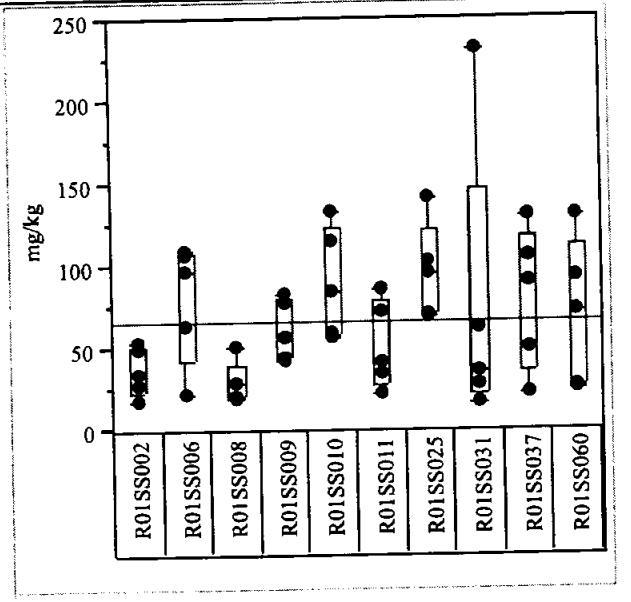
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS002	70.50	66.10	68.20	71.30	59.90
R01SS006	64.20	76.90	74.50	55.60	68.40
R01SS008	67.30	69.70	69.00	54.90	54.50
R01SS009	68.10	58.70	57.70	76.10	61.00
R01SS010	61.20	81.30	84.30	54.90	73.20
R01SS011	86.40	75.80	74.80	63.90	64.00
R01SS025	76.90	53.60	58.00	73.80	76.70
R01SS031	99.90	55.80	82.60	63.70	42.20
R01SS037	53.30	117.00	179.00	72.50	138.00
R01SS060	111.00	62.00	149.00	100.00	48.20

Spatial Unit 2, LEAD

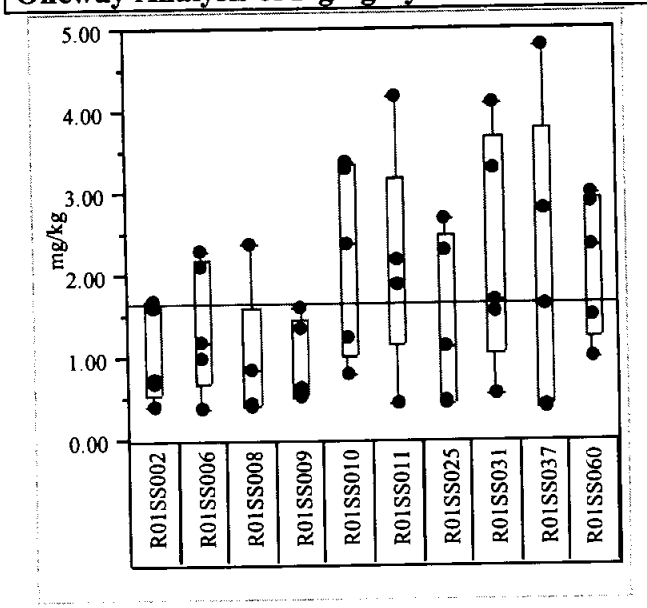
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS002	49.80	28.10	53.50	34.90	18.70
R01SS006	110.00	97.10	107.00	22.60	63.40
R01SS008	29.40	29.60	50.70	20.00	20.60
R01SS009	78.20	57.20	44.20	84.00	43.40
R01SS010	85.40	60.00	115.00	56.90	133.00
R01SS011	72.70	34.30	85.80	41.40	22.10
R01SS025	142.00	70.00	70.70	95.50	103.00
R01SS031	232.00	36.10	62.30	28.20	17.00
R01SS037	21.70	89.70	131.00	50.50	105.00
R01SS060	92.90	26.60	131.00	72.20	25.40

Spatial Unit 2, SELENIUM

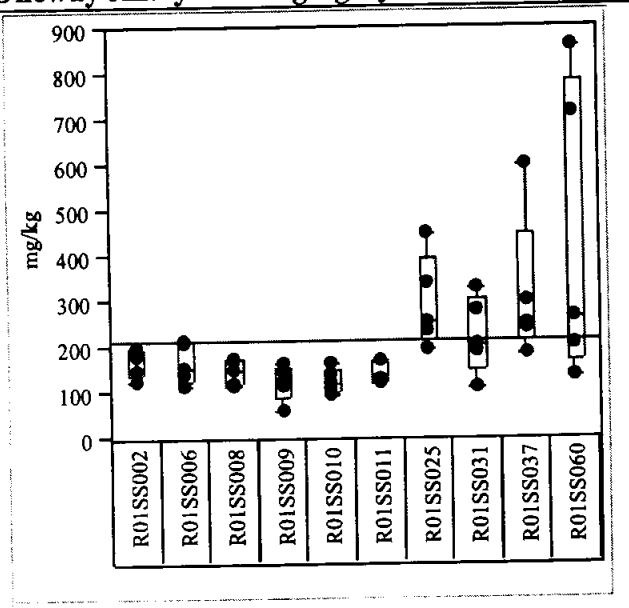
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS002	0.75	0.42	0.69	1.70	1.60
R01SS006	1.00	0.40	1.20	2.30	2.10
R01SS008	0.85	0.44	0.41	2.40	0.85
R01SS009	1.35	0.53	0.65	1.60	0.55
R01SS010	1.25	3.30	0.80	2.40	3.40
R01SS011	2.20	4.20	0.45	2.20	1.90
R01SS025	1.15	0.45	0.46	2.70	2.30
R01SS031	1.55	4.10	0.55	1.70	3.30
R01SS037	1.65	0.41	0.40	4.80	2.80
R01SS060	2.35	1.00	1.50	3.00	2.90

Spatial Unit 2, ZINC

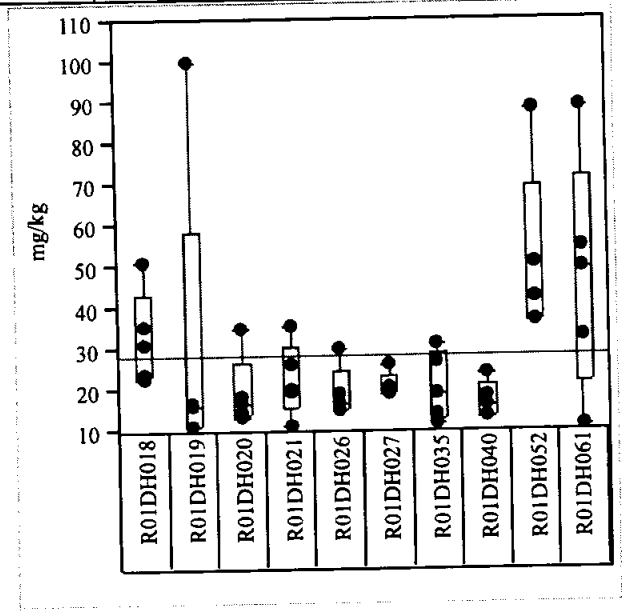
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS002	179.00	149.00	202.00	188.00	127.00
R01SS006	157.00	212.00	214.00	113.00	139.00
R01SS008	171.00	148.00	175.00	122.00	115.00
R01SS009	165.00	147.00	123.00	117.00	60.30
R01SS010	110.00	119.00	164.00	94.40	140.00
R01SS011	172.00	170.00	124.00	118.00	130.00
R01SS025	341.00	253.00	449.00	194.00	236.00
R01SS031	282.00	190.00	331.00	206.00	109.00
R01SS037	187.00	300.00	601.00	239.00	252.00
R01SS060	263.00	204.00	860.00	715.00	137.00

Spatial Unit 3, ARSENIC

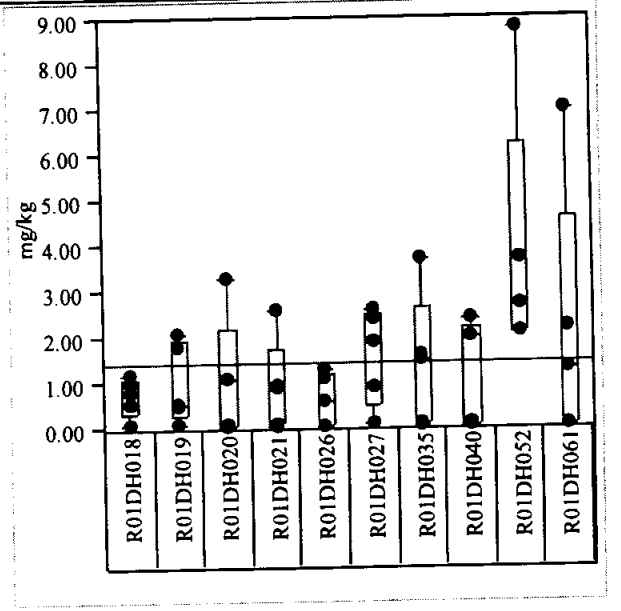
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH018	35.30	50.90	31.00	22.60	23.80
R01DH019	16.70	100.00	11.30	16.20	10.90
R01DH020	16.70	35.10	18.10	13.30	14.50
R01DH021	19.50	35.30	11.30	26.30	19.80
R01DH026	30.10	18.90	15.10	16.80	15.10
R01DH027	18.90	19.40	26.10	20.20	20.80
R01DH035	19.10	30.90	14.00	11.40	26.60
R01DH040	18.50	23.70	13.50	13.40	15.90
R01DH052	50.30	42.50	88.20	36.80	36.80
R01DH061	10.90	32.60	88.90	54.70	49.50

Spatial Unit 3, CADMIUM

Oneway Analysis of mg/kg By LOCATION

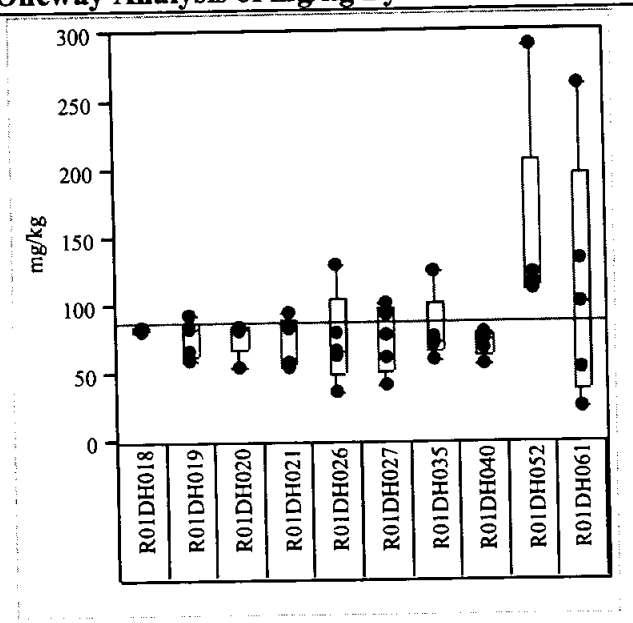


Location	Round 1	2	3	4	5
R01DH018	0.81	1.20	0.12	0.55	1.00
R01DH019	2.10	1.80	0.09	0.50	0.57
R01DH020	1.10	0.06	0.08	1.10	3.30
R01DH021	0.88	0.08	0.09	0.95	2.60
R01DH026	0.62	0.05	0.07	1.30	1.10
R01DH027	1.90	0.10	2.40	0.92	2.60
R01DH035	0.10	0.07	1.50	1.60	3.70
R01DH040	0.08	0.07	2.00	2.40	2.00
R01DH052	2.10	2.10	8.80	3.70	2.70
R01DH061	0.06	0.05	7.00	1.30	2.20

DS.0373.15382

Spatial Unit 3, COPPER

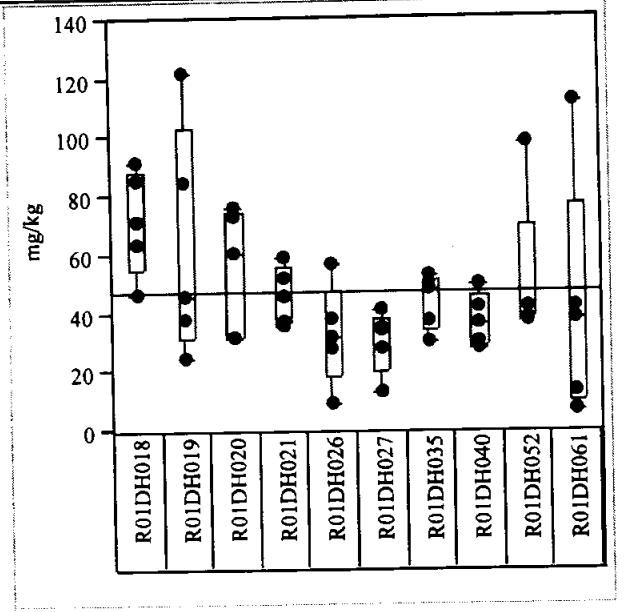
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH018	80.90	84.30	83.70	84.50	85.20
R01DH019	83.70	93.00	60.30	85.30	66.80
R01DH020	84.30	54.30	84.20	84.00	81.10
R01DH021	83.20	55.70	57.60	83.60	95.30
R01DH026	130.00	62.80	67.40	36.80	80.40
R01DH027	78.40	61.80	102.00	41.10	93.70
R01DH035	72.50	59.30	73.50	77.40	125.00
R01DH040	77.50	68.80	80.00	56.50	75.80
R01DH052	112.00	116.00	290.00	116.00	124.00
R01DH061	24.50	53.20	261.00	101.00	133.00

Spatial Unit 3, LEAD

Oneway Analysis of mg/kg By LOCATION

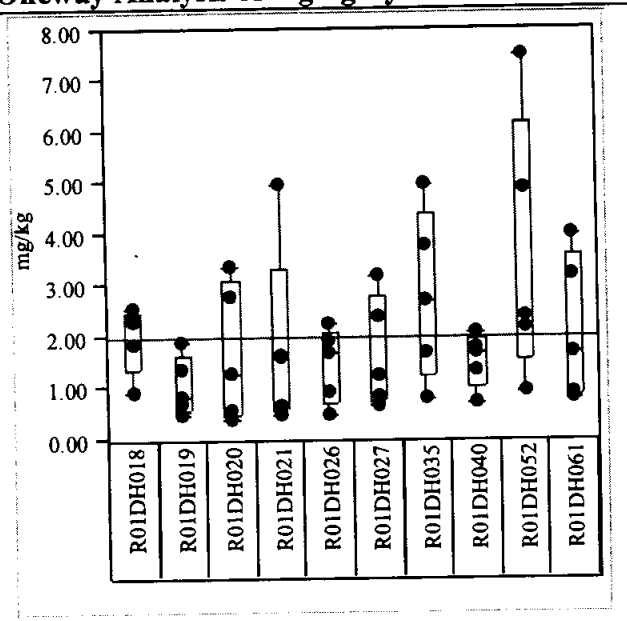


Location	Round 1	2	3	4	5
R01DH018	85.70	91.40	71.80	63.60	47.00
R01DH019	38.40	122.00	84.80	45.90	25.20
R01DH020	32.10	73.00	76.60	60.90	31.70
R01DH021	37.10	52.50	46.20	59.50	36.00
R01DH026	57.00	31.90	38.40	9.30	28.30
R01DH027	34.40	28.20	41.10	12.90	34.90
R01DH035	37.70	48.60	30.30	52.70	49.40
R01DH040	36.50	49.70	42.30	30.00	27.70
R01DH052	37.40	42.20	98.10	38.10	42.30
R01DH061	6.70	13.40	112.00	42.30	37.90

DS.0373.15382

Spatial Unit 3, SELENIUM

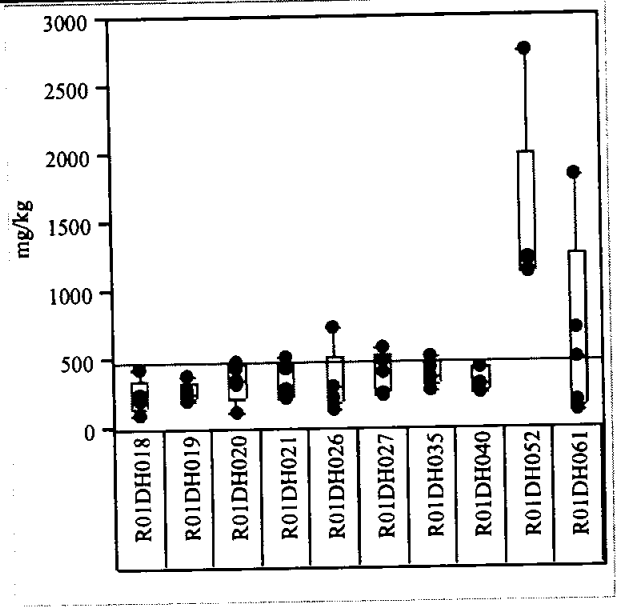
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH018	1.85	2.60	0.95	2.40	2.30
R01DH019	1.40	0.47	0.70	1.90	0.85
R01DH020	1.30	0.40	0.60	3.40	2.80
R01DH021	1.65	0.51	0.65	5.00	1.60
R01DH026	2.25	0.92	0.50	1.70	1.90
R01DH027	1.25	0.68	0.85	3.20	2.40
R01DH035	1.70	2.70	0.80	3.80	5.00
R01DH040	1.35	2.10	0.70	1.70	1.80
R01DH052	7.50	0.95	2.20	4.90	2.40
R01DH061	0.90	1.70	4.00	3.20	0.80

Spatial Unit 3, ZINC

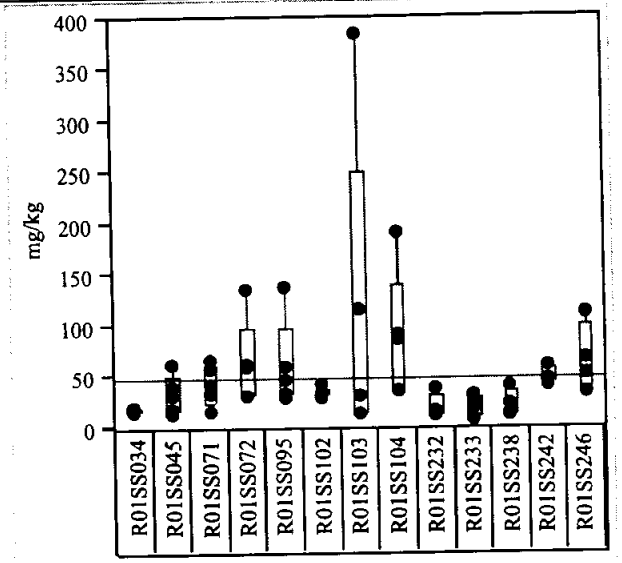
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH018	441.00	200.00	99.80	254.00	213.00
R01DH019	385.00	227.00	279.00	244.00	201.00
R01DH020	483.00	118.00	355.00	320.00	438.00
R01DH021	518.00	210.00	220.00	278.00	438.00
R01DH026	732.00	223.00	296.00	129.00	293.00
R01DH027	481.00	234.00	576.00	257.00	401.00
R01DH035	439.00	269.00	354.00	368.00	520.00
R01DH040	433.00	325.00	426.00	242.00	295.00
R01DH052	1,220.00	1,240.00	2,750.00	1,140.00	1,130.00
R01DH061	118.00	179.00	1,840.00	500.00	709.00

Spatial Unit 4, ARSENIC

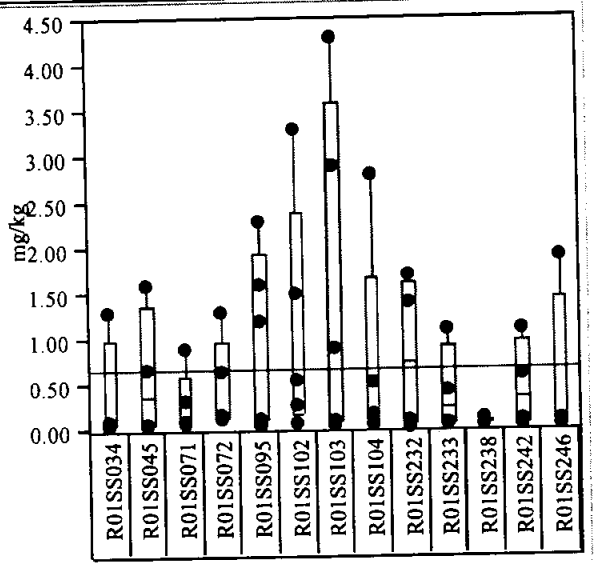
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS034		20.10	18.70	17.90	14.60
R01SS045	31.60	39.60	61.70	17.90	14.20
R01SS071	42.90	58.50	66.50	16.10	33.70
R01SS072	61.70	135.00	31.30	30.90	60.80
R01SS095	137.00	45.70	30.00	60.00	34.20
R01SS102	43.10	33.10	32.10	29.80	30.90
R01SS103	385.00	14.20	31.20	14.20	116.00
R01SS104	36.00	191.00	36.40	90.80	87.70
R01SS232		15.50	37.70	11.20	13.10
R01SS233		21.70	30.20	18.30	6.60
R01SS238		21.40	40.60	11.30	12.80
R01SS242		40.70	44.60	60.60	47.40
R01SS246		111.00	33.70	65.80	50.40

Spatial Unit 4, CADMIUM

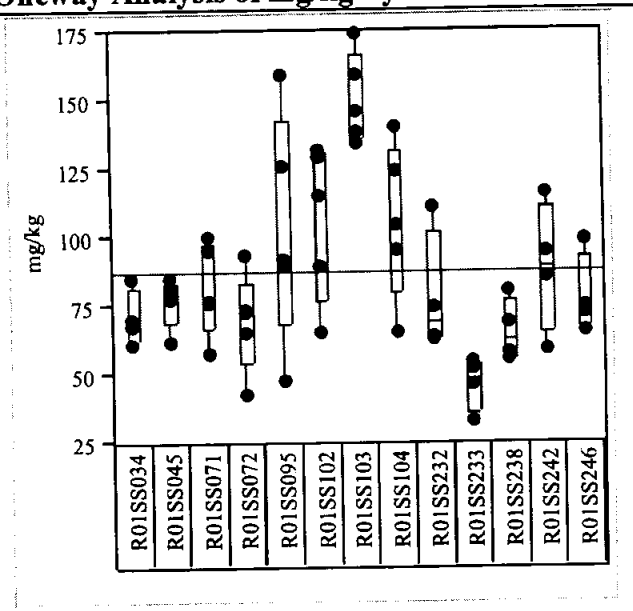
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS034		1.30	0.04	0.07	0.11
R01SS045		1.60	0.08	0.05	0.67
R01SS071	0.90	0.32	0.08	0.11	0.07
R01SS072	0.14	1.30	0.12	0.18	0.66
R01SS095	2.30	1.60	0.05	0.13	1.20
R01SS102	0.07	0.55	1.50	0.28	3.30
R01SS103	4.30	0.91	0.06	0.09	2.90
R01SS104	0.53	2.80	0.06	0.18	0.06
R01SS232		1.40	0.10	0.03	1.70
R01SS233		1.10	0.08	0.05	0.43
R01SS238		0.12	0.06	0.05	0.06
R01SS242		0.09	0.59	0.05	1.10
R01SS246		1.90	0.09	0.06	0.06

Spatial Unit 4, COPPER

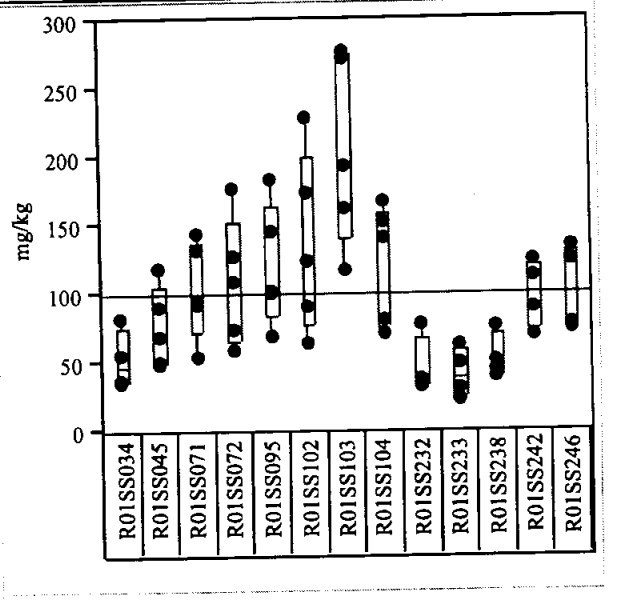
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS034		69.60	60.70	85.30	67.60
R01SS045	77.10	79.20	85.40	61.70	80.70
R01SS071	76.10	76.80	94.90	57.90	99.70
R01SS072	65.20	93.30	72.70	42.80	73.50
R01SS095	126.00	91.60	47.70	159.00	88.90
R01SS102	64.60	88.90	132.00	115.00	129.00
R01SS103	159.00	146.00	134.00	138.00	174.00
R01SS104	140.00	104.00	65.40	94.90	124.00
R01SS232		74.10	111.00	62.60	63.60
R01SS233		53.80	32.90	51.30	45.50
R01SS238		57.10	79.60	54.70	68.20
R01SS242		94.20	58.10	84.90	116.00
R01SS246		98.40	71.70	74.40	65.00

Spatial Unit 4, LEAD

Oneway Analysis of mg/kg By LOCATION

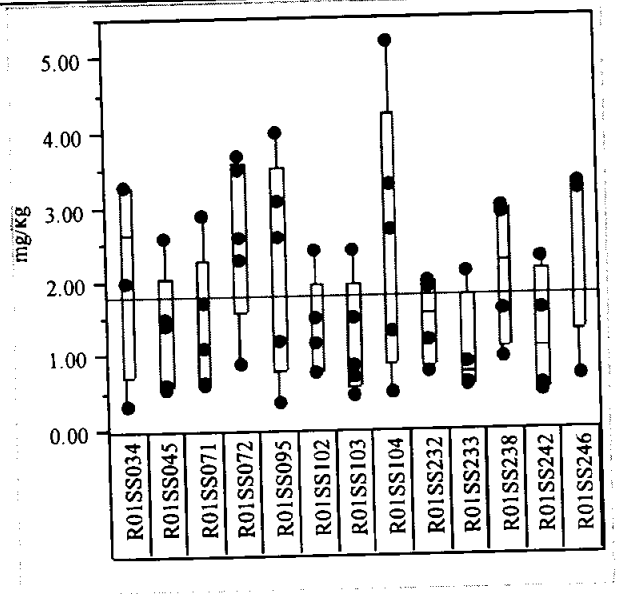


Location	Round 1	2	3	4	5
R01SS034		55.00	35.30	81.40	36.80
R01SS045	67.80	119.00	89.60	47.60	50.70
R01SS071	95.70	91.40	144.00	53.40	131.00
R01SS072	108.00	177.00	72.90	58.20	127.00
R01SS095	183.00	101.00	68.00	145.00	99.80
R01SS102	63.10	89.20	228.00	124.00	173.00
R01SS103	117.00	272.00	277.00	193.00	162.00
R01SS104	80.80	140.00	69.80	166.00	152.00
R01SS232		32.00	76.00	36.10	33.30
R01SS233		47.80	30.30	61.00	21.70
R01SS238		49.90	75.80	42.60	37.60
R01SS242		111.00	68.20	88.40	124.00
R01SS246		133.00	74.00	124.00	77.20

DS.0373.15382

Spatial Unit 4, SELENIUM

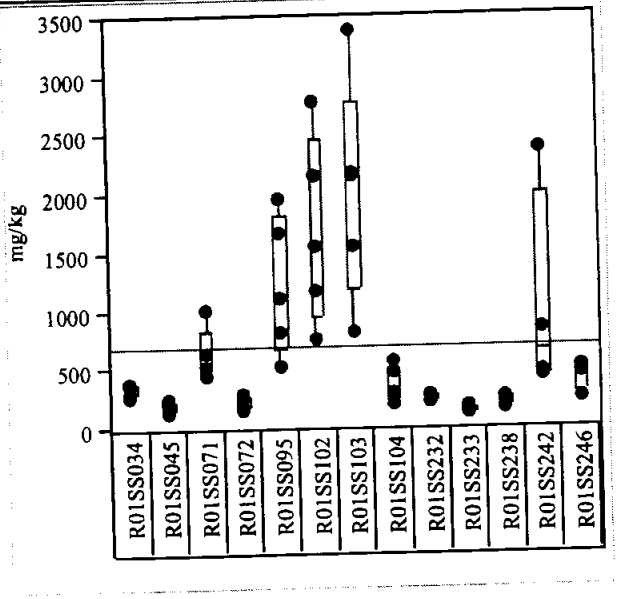
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS034		3.30	0.33	3.30	2.00
R01SS045	1.40	0.54	0.60	2.60	1.50
R01SS071	1.10	0.64	0.60	2.90	1.70
R01SS072	2.60	3.50	0.90	3.70	2.30
R01SS095	3.10	1.20	0.38	4.00	2.60
R01SS102	1.15	0.76	0.75	2.40	1.50
R01SS103	0.70	0.85	0.47	1.50	2.40
R01SS104	1.30	3.30	0.48	5.20	2.70
R01SS232		2.00	0.75	1.20	1.90
R01SS233		0.58	0.60	2.10	0.90
R01SS238		3.00	0.94	2.90	1.60
R01SS242		0.59	0.49	2.30	1.60
R01SS246		3.30	0.70	3.20	3.20

Spatial Unit 4, ZINC

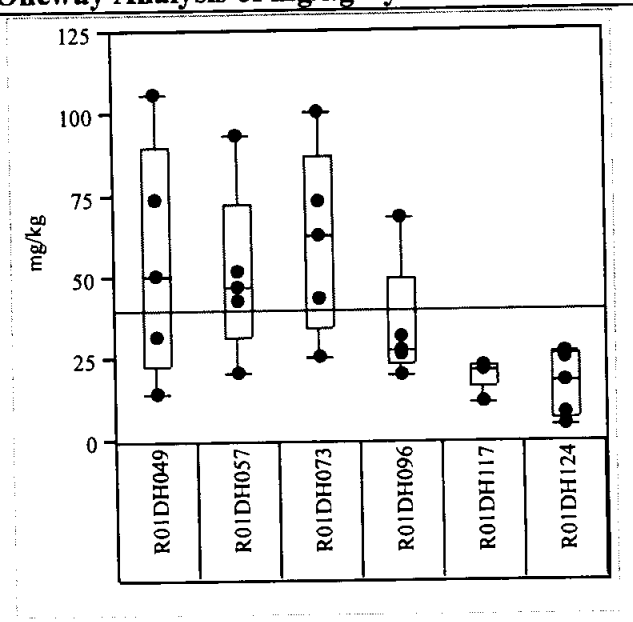
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS034		301.00	378.00	384.00	281.00
R01SS045	205.00	248.00	151.00	141.00	197.00
R01SS071	638.00	447.00	1,020.00	637.00	516.00
R01SS072	179.00	253.00	292.00	174.00	163.00
R01SS095	1,970.00	1,100.00	529.00	1,670.00	823.00
R01SS102	754.00	1,170.00	2,160.00	1,560.00	2,790.00
R01SS103	1,550.00	2,150.00	2,170.00	818.00	3,380.00
R01SS104	204.00	297.00	246.00	459.00	565.00
R01SS232		209.00	211.00	270.00	252.00
R01SS233		137.00	119.00	167.00	118.00
R01SS238		249.00	221.00	248.00	161.00
R01SS242		424.00	468.00	836.00	2,380.00
R01SS246		454.00	502.00	469.00	235.00

Spatial Unit 5, ARSENIC

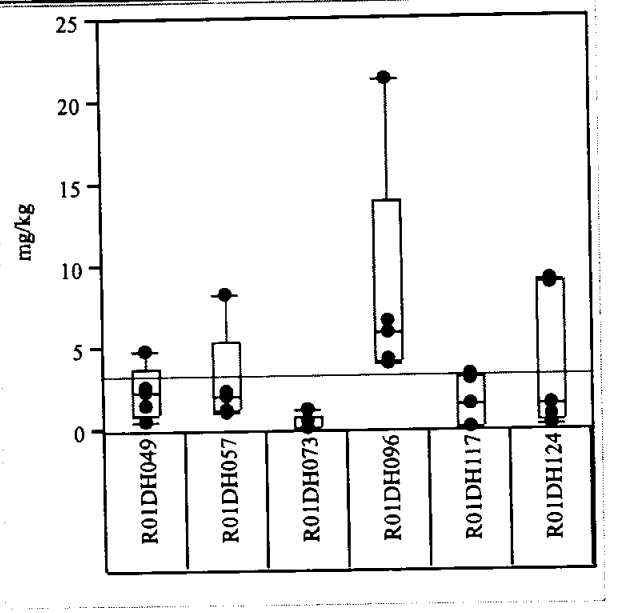
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH049	74.00	106.00	31.80	14.50	51.00
R01DH057	93.90	51.80	43.00	47.00	20.50
R01DH073	73.70	43.50	25.40	101.00	63.50
R01DH096	31.60	19.90	68.80	26.70	27.50
R01DH117	21.80	22.60	12.00	23.20	21.60
R01DH124	25.20	27.00	8.60	18.10	4.80

Spatial Unit 5, CADMIUM

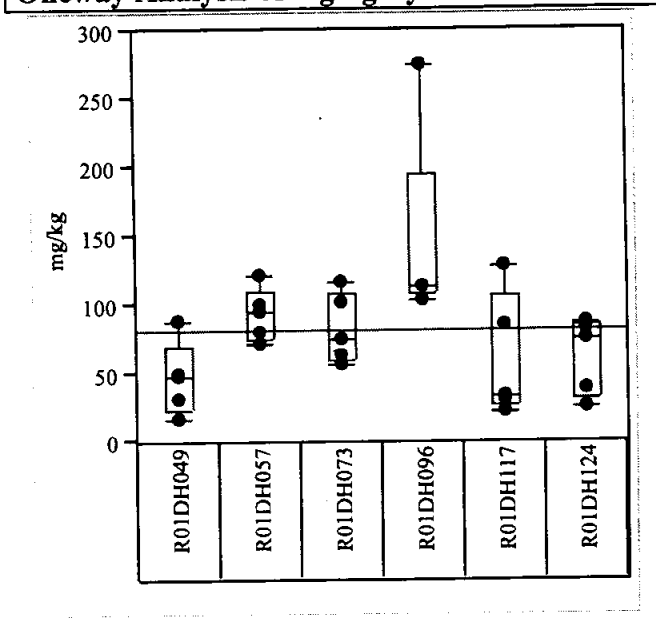
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH049	4.90	2.30	2.70	0.51	1.50
R01DH057	8.40	2.10	2.40	1.10	1.30
R01DH073	0.16	0.60	0.09	0.17	1.20
R01DH096	6.00	6.60	21.40	4.30	4.00
R01DH117	0.13	1.50	0.13	3.00	3.40
R01DH124	8.90	0.86	9.10	1.50	0.21

Spatial Unit 5, COPPER

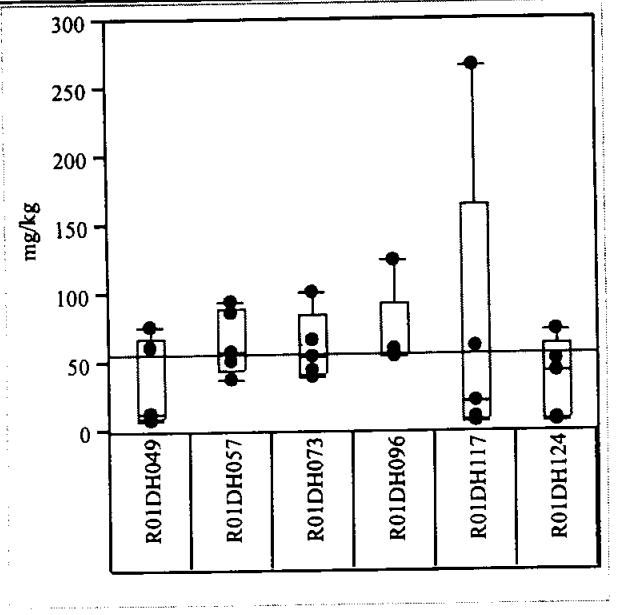
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH049	49.00	88.80	50.80	16.00	31.00
R01DH057	121.00	100.00	94.40	79.60	71.20
R01DH073	101.00	117.00	63.60	56.10	75.20
R01DH096	113.00	113.00	275.00	114.00	104.00
R01DH117	21.40	129.00	30.80	85.10	33.40
R01DH124	82.10	87.20	38.10	75.10	25.30

Spatial Unit 5, LEAD

Oneway Analysis of mg/kg By LOCATION

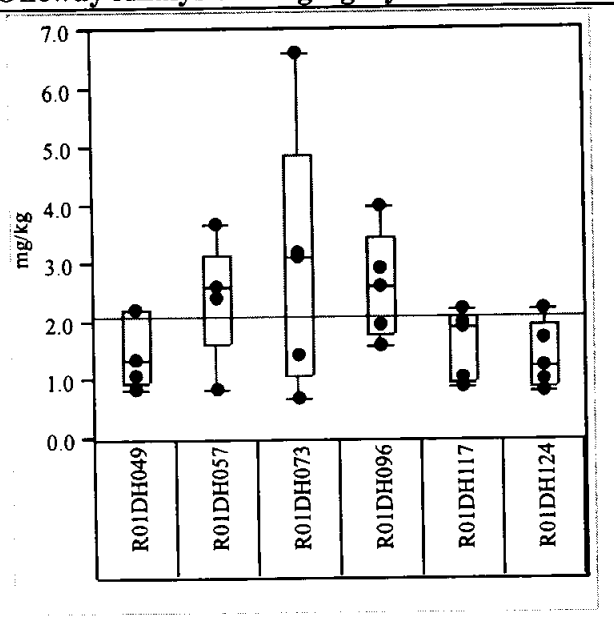


Location	Round 1	2	3	4	5
R01DH049	61.60	76.40	11.30	8.20	12.60
R01DH057	86.20	94.50	58.00	52.10	38.00
R01DH073	102.00	66.60	54.80	39.50	44.20
R01DH096	57.20	60.50	125.00	56.70	54.20
R01DH117	10.50	266.00	21.60	62.40	7.10
R01DH124	52.40	72.70	8.80	43.00	6.60

DS.0373.15382

Spatial Unit 5, SELENIUM

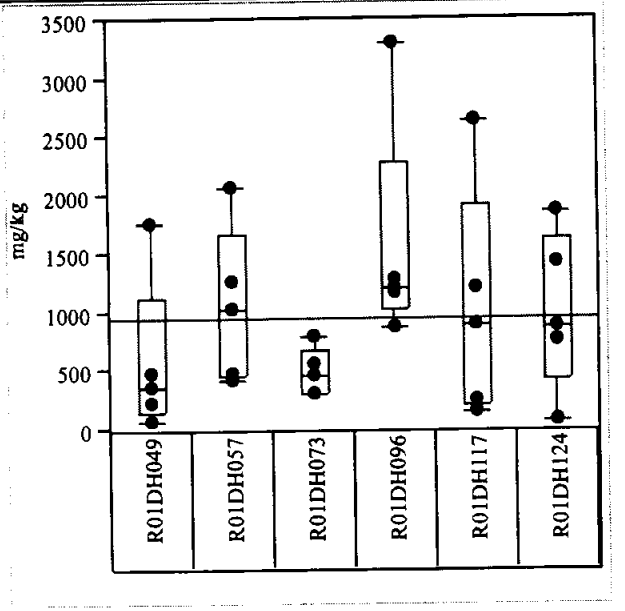
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH049	1.35	0.88	1.10	2.20	2.20
R01DH057	2.60	2.60	0.85	3.70	2.40
R01DH073	3.10	1.45	0.70	6.60	3.20
R01DH096	1.95	4.00	1.60	2.60	2.90
R01DH117	1.90	2.00	1.05	2.20	0.90
R01DH124	1.25	1.70	0.80	2.20	1.00

Spatial Unit 5, ZINC

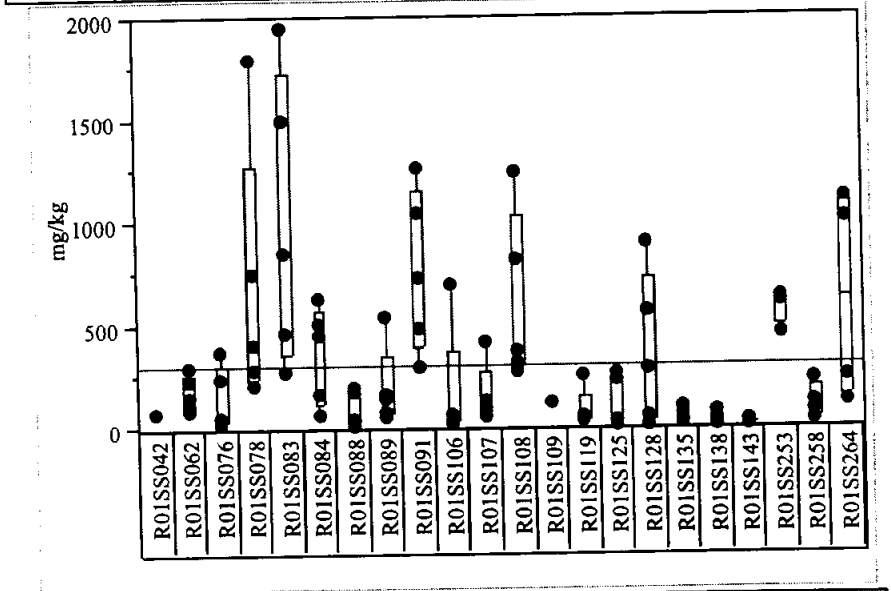
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH049	1,770.00	492.00	365.00	74.40	237.00
R01DH057	2,080.00	1,040.00	435.00	1,260.00	480.00
R01DH073	797.00	476.00	564.00	310.00	316.00
R01DH096	1,280.00	1,170.00	3,300.00	1,200.00	879.00
R01DH117	259.00	2,650.00	165.00	1,210.00	887.00
R01DH124	1,860.00	1,420.00	768.00	867.00	77.60

Spatial Unit 6, ARSENIC

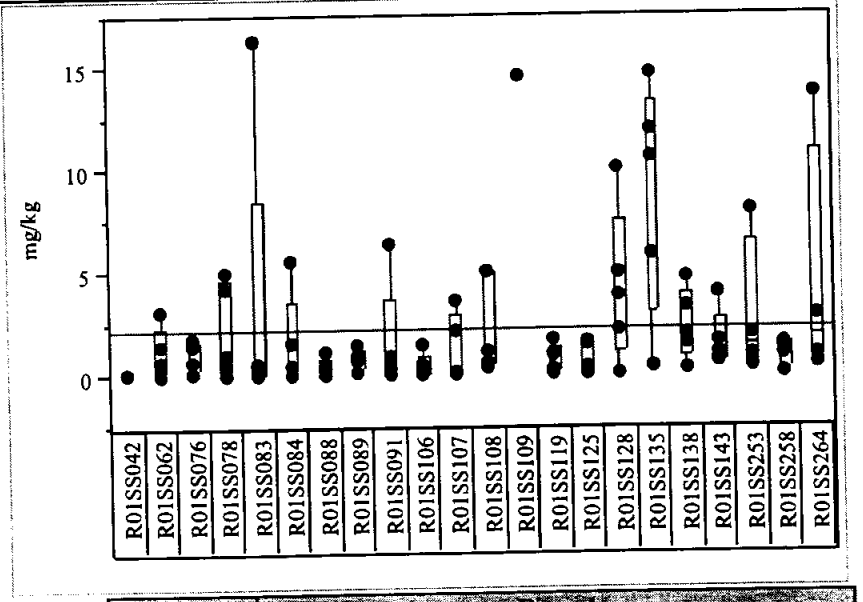
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042					73.70
R01SS062	229.00	93.10	302.00	112.00	156.00
R01SS076	377.00	22.30	248.00	55.50	41.90
R01SS078	759.00	1,800.00	412.00	284.00	214.00
R01SS083	1,960.00	273.00	1,500.00	861.00	470.00
R01SS084	632.00	66.40	515.00	452.00	172.00
R01SS088	195.00	16.60	182.00	34.80	44.60
R01SS089	545.00	149.00	76.30	167.00	53.80
R01SS091	1,050.00	1,270.00	493.00	734.00	304.00
R01SS106	31.70	61.30	36.70	705.00	25.30
R01SS107	418.00	55.90	95.10	74.40	131.00
R01SS108	1,250.00	819.00	274.00	380.00	324.00
R01SS109				123.00	
R01SS119	259.00	46.80	51.70	28.90	60.00
R01SS125	32.40	24.10	234.00	10.10	262.00
R01SS128	13.10	903.00	569.00	55.40	294.00
R01SS135	38.30	24.10	66.50	102.00	67.70
R01SS138	21.80	33.10	20.50	13.80	77.70
R01SS143	10.20	12.90	29.00	7.90	12.40
R01SS253		458.00	636.00	607.00	622.00
R01SS258		38.60	118.00	76.90	230.00
R01SS264		122.00	1,010.00	1,110.00	249.00

Spatial Unit 6, CADMIUM

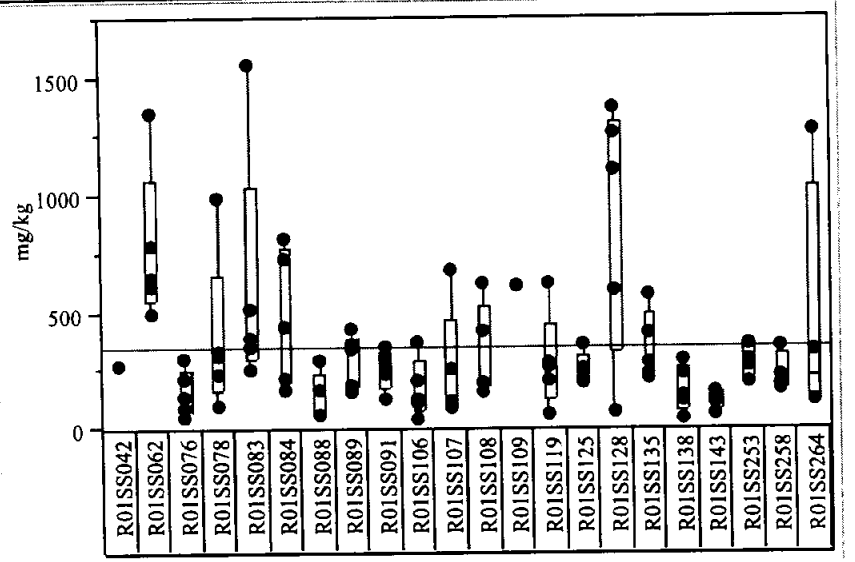
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042					0.18
R01SS062	0.07	0.41	3.20	0.68	1.50
R01SS076	0.14	1.50	1.80	0.67	1.70
R01SS078	0.11	0.50	4.30	1.10	5.10
R01SS083	0.08	0.14	16.40	0.59	0.48
R01SS084	0.08	0.55	5.60	0.54	1.60
R01SS088	0.08	0.40	1.20	0.07	0.19
R01SS089	0.12	0.76	0.99	0.83	1.50
R01SS091	0.10	0.40	6.40	0.10	1.00
R01SS106	0.05	0.43	0.08	0.46	1.50
R01SS107	0.15	3.60	0.13	0.04	2.20
R01SS108	0.66	0.39	5.10	5.10	1.20
R01SS109				14.60	
R01SS119	0.11	0.29	1.10	1.70	0.98
R01SS125	0.06	0.39	1.60	0.32	1.50
R01SS128	0.03	4.90	10.10	2.20	3.80
R01SS135	12.00	10.60	14.70	0.38	5.80
R01SS138	1.50	3.30	2.00	0.31	4.70
R01SS143	0.58	1.10	1.60	0.73	3.90
R01SS253		0.44	8.00	1.00	2.00
R01SS258		1.50	1.30	0.06	1.00
R01SS264		0.55	13.70	0.99	2.80

Spatial Unit 6, COPPER

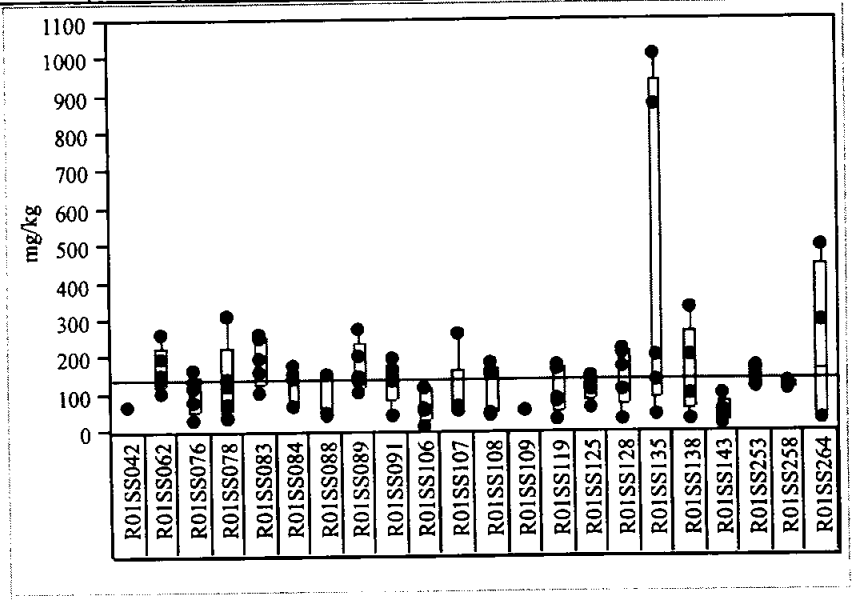
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042					268.00
R01SS062	784.00	496.00	1,350.00	616.00	647.00
R01SS076	299.00	45.60	212.00	135.00	90.40
R01SS078	310.00	327.00	992.00	234.00	99.50
R01SS083	390.00	249.00	1,560.00	513.00	348.00
R01SS084	441.00	214.00	734.00	813.00	169.00
R01SS088	168.00	62.80	291.00	55.70	61.60
R01SS089	424.00	361.00	159.00	337.00	182.00
R01SS091	306.00	346.00	249.00	231.00	123.00
R01SS106	42.20	129.00	208.00	371.00	109.00
R01SS107	678.00	89.20	97.90	256.00	112.00
R01SS108	627.00	415.00	196.00	420.00	155.00
R01SS109				616.00	
R01SS119	621.00	264.00	279.00	204.00	57.90
R01SS125	247.00	357.00	198.00	257.00	209.00
R01SS128	70.40	1,370.00	1,260.00	596.00	1,110.00
R01SS135	577.00	283.00	237.00	215.00	413.00
R01SS138	117.00	236.00	136.00	43.00	291.00
R01SS143	128.00	58.70	151.00	106.00	159.00
R01SS253		261.00	195.00	364.00	296.00
R01SS258		163.00	222.00	189.00	352.00
R01SS264		118.00	1,270.00	334.00	119.00

Spatial Unit 6, LEAD

Oneway Analysis of mg/kg By LOCATION

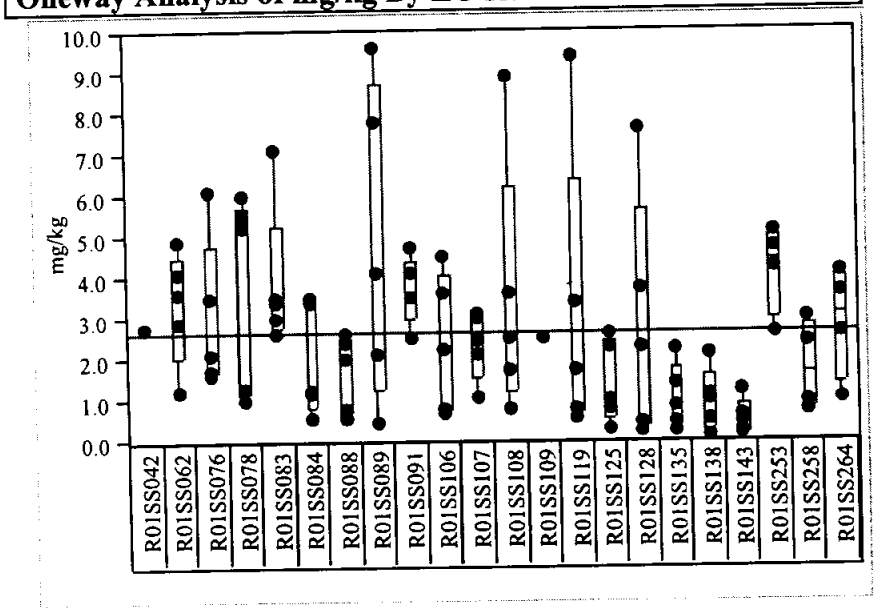


Location	Round 1	2	3	4	5
R01SS042					69.40
R01SS062	195.00	101.00	260.00	155.00	141.00
R01SS076	116.00	31.60	166.00	132.00	76.50
R01SS078	123.00	140.00	312.00	76.00	35.00
R01SS083	261.00	106.00	252.00	193.00	156.00
R01SS084	140.00	64.50	178.00	155.00	65.70
R01SS088	152.00	43.70	154.00	51.80	41.80
R01SS089	277.00	199.00	146.00	104.00	132.00
R01SS091	132.00	196.00	138.00	164.00	43.10
R01SS106	11.80	61.80	114.00	118.00	52.50
R01SS107	260.00	55.00	65.40	67.50	55.80
R01SS108	182.00	150.00	51.20	157.00	44.10
R01SS109				55.70	
R01SS119	165.00	78.00	178.00	85.60	32.10
R01SS125	113.00	117.00	121.00	147.00	63.70
R01SS128	32.60	219.00	205.00	112.00	170.00
R01SS135	1,010.00	872.00	199.00	45.30	132.00
R01SS138	99.60	201.00	95.90	30.10	332.00
R01SS143	37.30	28.20	99.20	54.20	19.10
R01SS253		139.00	118.00	171.00	168.00
R01SS258		108.00	126.00	115.00	130.00
R01SS264		32.70	295.00	[illegible]	[illegible]

DS.0373.15382

Spatial Unit 6, SELENIUM

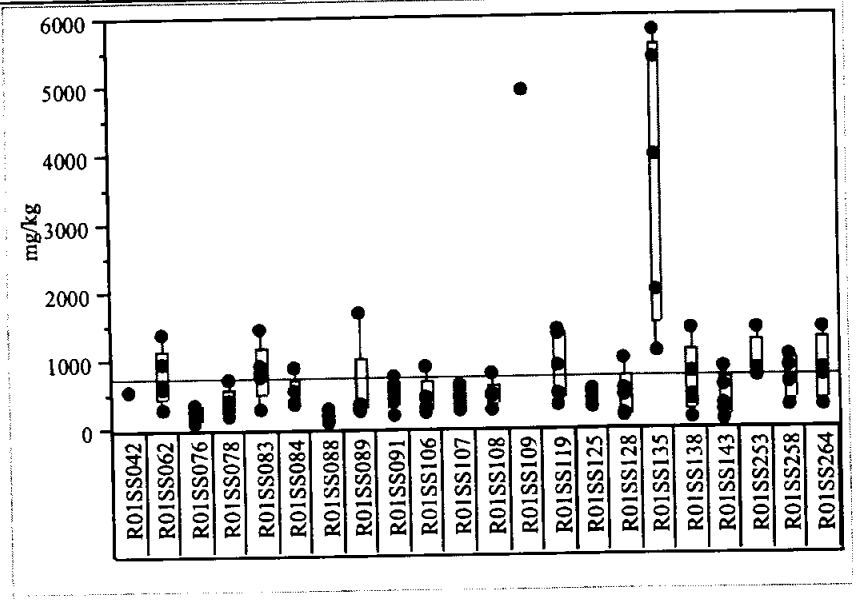
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042					2.80
R01SS062	1.20	4.90	4.10	2.90	3.60
R01SS076	1.70	3.50	1.60	6.10	2.10
R01SS078	1.30	1.00	5.50	5.20	6.00
R01SS083	7.10	2.60	3.00	3.50	3.40
R01SS084	1.20	1.15	0.55	3.40	3.50
R01SS088	2.60	0.80	0.55	2.40	2.00
R01SS089	9.60	2.10	0.47	7.80	4.10
R01SS091	3.50	4.70	3.50	4.10	2.50
R01SS106	0.80	3.60	0.65	4.50	2.20
R01SS107	2.45	3.10	1.05	2.10	3.00
R01SS108	8.90	0.78	1.70	3.60	2.50
R01SS109				2.50	
R01SS119	9.40	0.55	0.80	3.40	1.70
R01SS125	1.00	0.77	0.30	2.60	2.30
R01SS128	0.43	7.60	0.20	2.30	3.70
R01SS135	0.85	0.46	0.25	1.40	2.20
R01SS138	1.00	0.09	0.50	1.10	2.10
R01SS143	1.20	0.20	0.17	0.47	0.59
R01SS253		4.70	5.10	2.60	4.20
R01SS258		0.75	0.95	3.00	2.40
R01SS264		3.60	1.00	2.60	4.10

Spatial Unit 6, ZINC

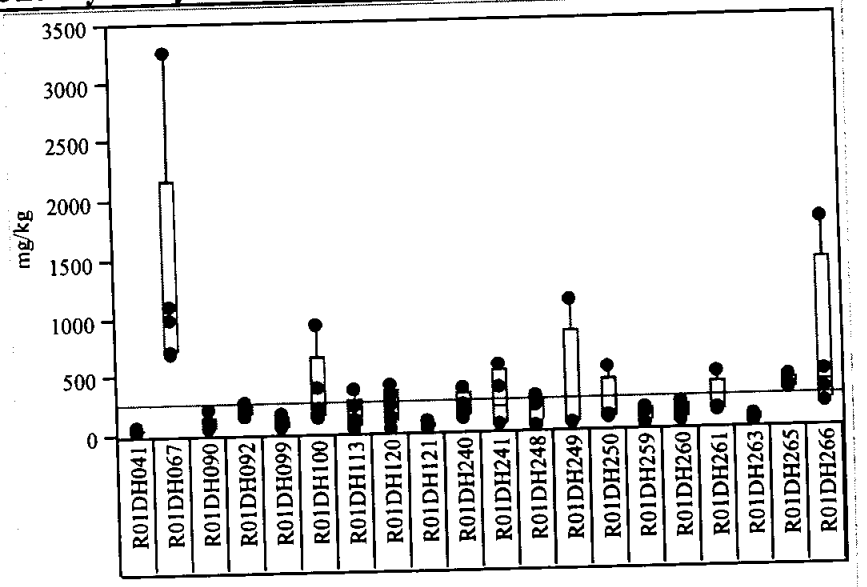
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042					582.00
R01SS062	291.00	956.00	1,410.00	612.00	671.00
R01SS076	116.00	172.00	277.00	371.00	352.00
R01SS078	310.00	403.00	730.00	437.00	204.00
R01SS083	780.00	288.00	1,460.00	850.00	947.00
R01SS084	560.00	353.00	912.00	410.00	376.00
R01SS088	201.00	116.00	312.00	215.00	123.00
R01SS089	363.00	316.00	360.00	1,700.00	256.00
R01SS091	209.00	600.00	774.00	559.00	432.00
R01SS106	239.00	312.00	898.00	441.00	472.00
R01SS107	598.00	464.00	631.00	262.00	303.00
R01SS108	469.00	464.00	501.00	794.00	251.00
R01SS109				4,940.00	
R01SS119	511.00	899.00	1,450.00	1,380.00	328.00
R01SS125	557.00	434.00	304.00	562.00	306.00
R01SS128	156.00	560.00	994.00	186.00	472.00
R01SS135	5,790.00	5,410.00	3,980.00	1,100.00	1,990.00
R01SS138	413.00	809.00	469.00	128.00	1,440.00
R01SS143	245.00	115.00	333.00	602.00	866.00
R01SS253		833.00	1,430.00	738.00	717.00
R01SS258		1,040.00	628.00	856.00	310.00
R01SS264		737.00	1,440.00	287.00	839.00

Spatial Unit 7, ARSENIC

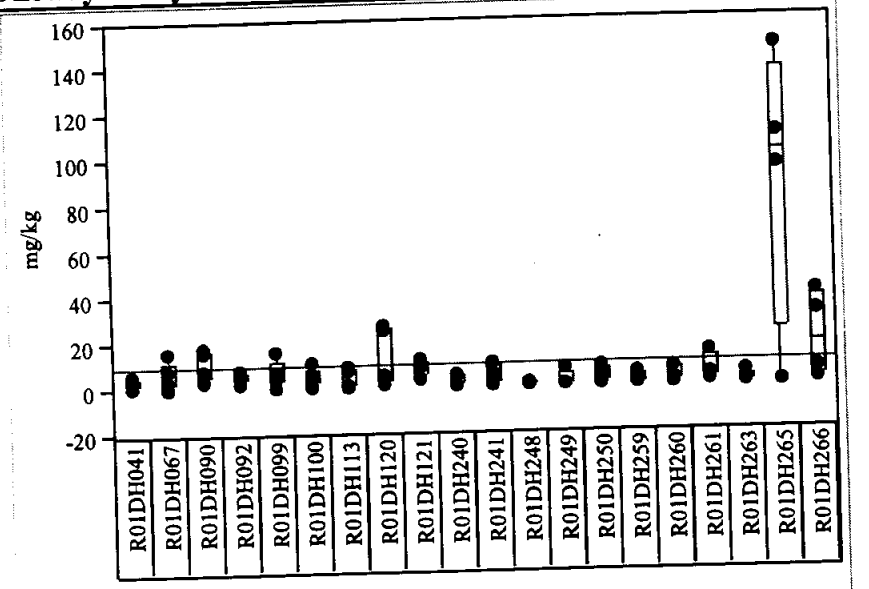
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH041	46.00	72.90	40.90	39.60	52.60
R01DH067	1,110.00	3,260.00	717.00	706.00	1,000.00
R01DH090	63.10	209.00	116.00	110.00	70.70
R01DH092	216.00	153.00	233.00	276.00	178.00
R01DH099	184.00	135.00	121.00	62.00	51.00
R01DH100	138.00	928.00	219.00	390.00	183.00
R01DH113	227.00	365.00	32.00	93.20	119.00
R01DH120	39.50	416.00	141.00	315.00	239.00
R01DH121	43.00	102.00	44.30	32.40	46.80
R01DH240		142.00	125.00	242.00	366.00
R01DH241		65.70	570.00	53.10	365.00
R01DH248		283.00	266.00	38.60	210.00
R01DH249		54.80	1,110.00	50.40	55.10
R01DH250		97.00	524.00	89.40	112.00
R01DH259		147.00	136.00	175.00	44.30
R01DH260		211.00	160.00	97.10	67.70
R01DH261		473.00	135.00	150.00	151.00
R01DH263		38.60	68.20	38.50	98.20
R01DH265		308.00	422.00	328.00	339.00
R01DH266		1,770.00	189.00	476.00	317.00

Spatial Unit 7, CADMIUM

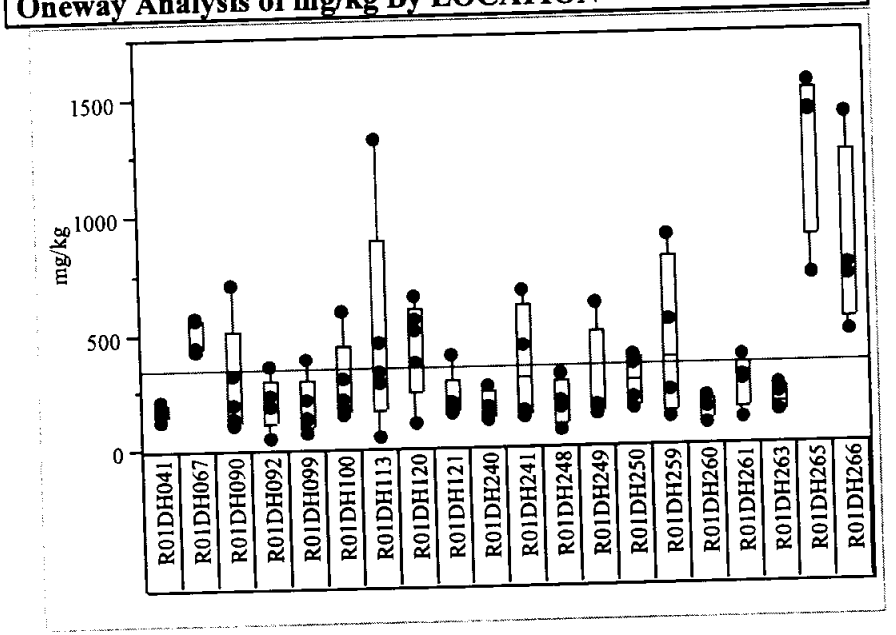
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH041	3.30	1.10	4.40	6.00	3.30
R01DH067	3.10	0.30	15.70	8.30	3.10
R01DH090	3.30	8.40	16.00	7.10	18.50
R01DH092	5.50	5.00	8.00	2.40	5.70
R01DH099	16.50	0.12	7.30	4.90	6.40
R01DH100	3.60	0.28	11.30	4.10	5.70
R01DH113	8.90	0.09	1.30	6.90	7.70
R01DH120	3.40	0.57	4.90	25.40	26.70
R01DH121	10.70	2.80	11.60	8.20	10.90
R01DH240		0.31	5.40	4.50	4.20
R01DH241		0.35	10.10	4.80	4.50
R01DH248		0.31	1.10	0.06	0.63
R01DH249		0.37	6.80	0.08	0.46
R01DH250		0.45	4.30	0.89	8.10
R01DH259		0.40	1.70	0.17	4.70
R01DH260		0.32	1.60	7.00	7.10
R01DH261		3.40	14.30	1.30	4.00
R01DH263		0.16	0.09	0.08	4.60
R01DH265		0.36	148.00	109.00	94.60
R01DH266		0.56	40.10	6.00	30.70

Spatial Unit 7, COPPER

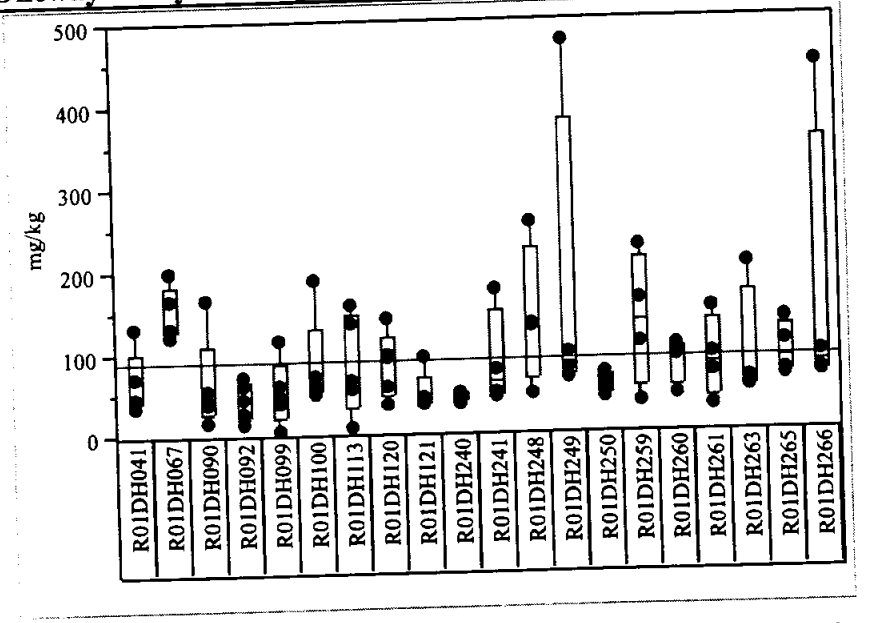
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH041	156.00	214.00	131.00	187.00	201.00
R01DH067	569.00	566.00	445.00	432.00	438.00
R01DH090	133.00	712.00	105.00	192.00	324.00
R01DH092	238.00	44.70	233.00	356.00	180.00
R01DH099	392.00	218.00	67.90	135.00	122.00
R01DH100	171.00	595.00	302.00	145.00	213.00
R01DH113	461.00	1,320.00	49.90	279.00	329.00
R01DH120	110.00	507.00	373.00	649.00	550.00
R01DH121	167.00	403.00	179.00	148.00	190.00
R01DH240		118.00	173.00	133.00	261.00
R01DH241		124.00	670.00	156.00	442.00
R01DH248		194.00	313.00	71.60	168.00
R01DH249		172.00	610.00	139.00	161.00
R01DH250		154.00	349.00	388.00	208.00
R01DH259		533.00	898.00	232.00	113.00
R01DH260		157.00	203.00	87.10	151.00
R01DH261		375.00	109.00	289.00	276.00
R01DH263		139.00	215.00	140.00	249.00
R01DH265		716.00	1,540.00	1,420.00	1,410.00
R01DH266		1,400.00	760.00	481.00	705.00

Spatial Unit 7, LEAD

Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH041	44.30	133.00	37.00	48.30	73.20
R01DH067	168.00	199.00	122.00	133.00	134.00
R01DH090	38.70	167.00	17.60	44.70	56.10
R01DH092	61.00	15.00	71.10	27.90	43.60
R01DH099	61.50	116.00	5.30	47.20	40.10
R01DH100	48.70	188.00	71.80	59.80	55.30
R01DH113	135.00	158.00	8.20	56.40	67.40
R01DH120	37.50	94.80	57.20	142.00	97.60
R01DH121	36.60	93.20	41.40	37.40	45.60
R01DH240		47.20	41.40	49.50	37.40
R01DH241		43.40	77.50	175.00	50.70
R01DH248		131.00	255.00	45.90	132.00
R01DH249		97.80	475.00	77.10	67.00
R01DH250		63.50	72.80	41.60	51.20
R01DH259		162.00	226.00	109.00	36.70
R01DH260		90.70	106.00	98.60	45.50
R01DH261		149.00	31.40	72.20	95.70
R01DH263		62.80	204.00	56.40	51.80
R01DH265		136.00	107.00	67.00	71.30
R01DH266		444.00	71.80	94.80	70.10

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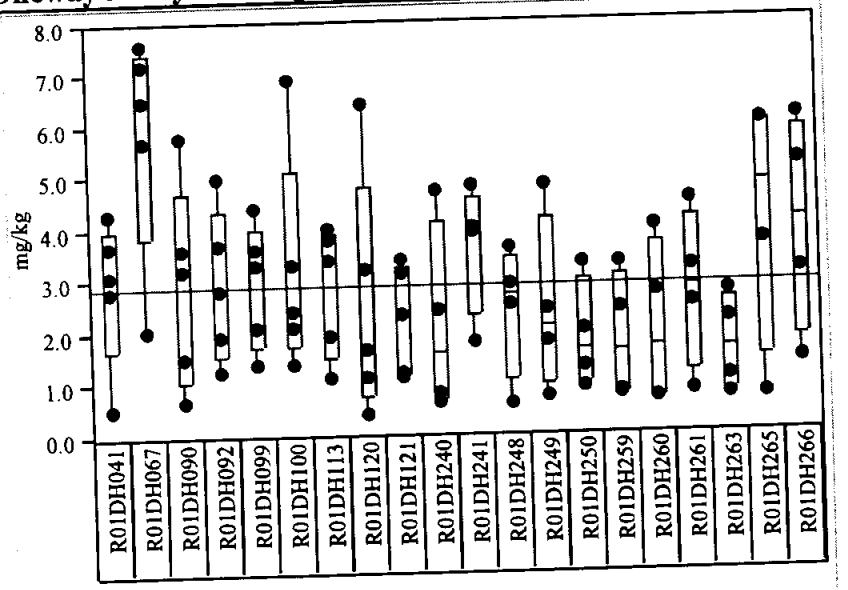
Spatial Unit 7, SELENIUM

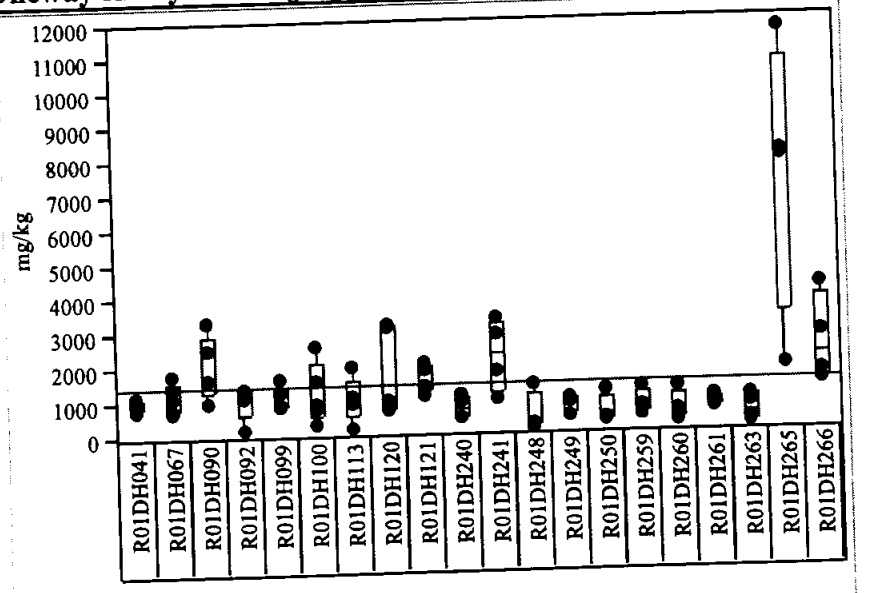
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH041	3.10	4.30	0.55	3.70	2.80
R01DH067	2.05	7.60	7.20	6.50	5.70
R01DH090	1.50	3.60	0.65	5.80	3.20
R01DH092	1.90	1.25	5.00	2.80	3.70
R01DH099	2.10	3.60	1.40	4.40	3.30
R01DH100	2.10	6.90	2.40	1.40	3.30
R01DH113	1.90	3.80	1.10	4.00	3.40
R01DH120	1.65	1.10	0.38	6.40	3.20
R01DH121	1.20	3.10	1.10	3.40	2.30
R01DH240		0.62	0.80	2.40	4.70
R01DH241		4.00	4.80	1.80	3.90
R01DH248		0.60	3.60	2.50	2.90
R01DH249		0.73	1.80	4.80	2.40
R01DH250		0.89	1.30	2.00	3.30
R01DH259		0.80	0.75	3.30	2.40
R01DH260		0.65	0.65	4.00	2.70
R01DH261		0.79	3.20	2.50	4.50
R01DH263		1.05	0.70	2.70	2.20
R01DH265		0.72	6.00	6.00	3.70
R01DH266		6.10	1.40	5.20	3.10

Spatial Unit 7, ZINC

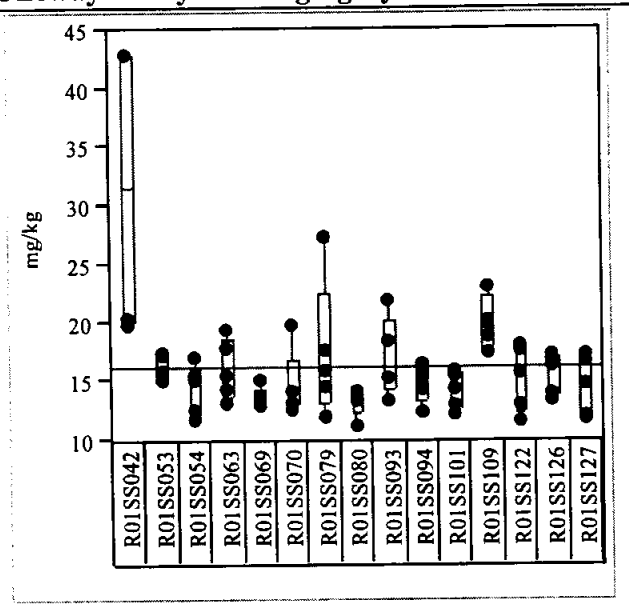
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01DH041	1,170.00	1,000.00	941.00	1,070.00	825.00
R01DH067	1,410.00	832.00	1,830.00	1,150.00	759.00
R01DH090	1,020.00	1,680.00	2,550.00	1,660.00	3,320.00
R01DH092	1,340.00	1,310.00	1,430.00	169.00	1,120.00
R01DH099	1,650.00	943.00	1,290.00	878.00	859.00
R01DH100	826.00	2,600.00	1,620.00	361.00	904.00
R01DH113	2,010.00	950.00	203.00	1,030.00	1,150.00
R01DH120	802.00	985.00	711.00	3,160.00	3,210.00
R01DH121	2,040.00	1,430.00	1,890.00	1,150.00	1,960.00
R01DH240		486.00	1,140.00	485.00	960.00
R01DH241		981.00	3,330.00	2,900.00	1,780.00
R01DH248		158.00	1,400.00	275.00	209.00
R01DH249		1,000.00	953.00	435.00	876.00
R01DH250		390.00	345.00	409.00	1,200.00
R01DH259		1,280.00	683.00	456.00	730.00
R01DH260		409.00	269.00	590.00	1,260.00
R01DH261		865.00	955.00	644.00	969.00
R01DH263		322.00	803.00	199.00	1,030.00
R01DH265		1,850.00	11,700.00	8,070.00	7,950.00
R01DH266		1,670.00	4,220.00	1,430.00	2,780.00

Spatial Unit 8, ARSENIC

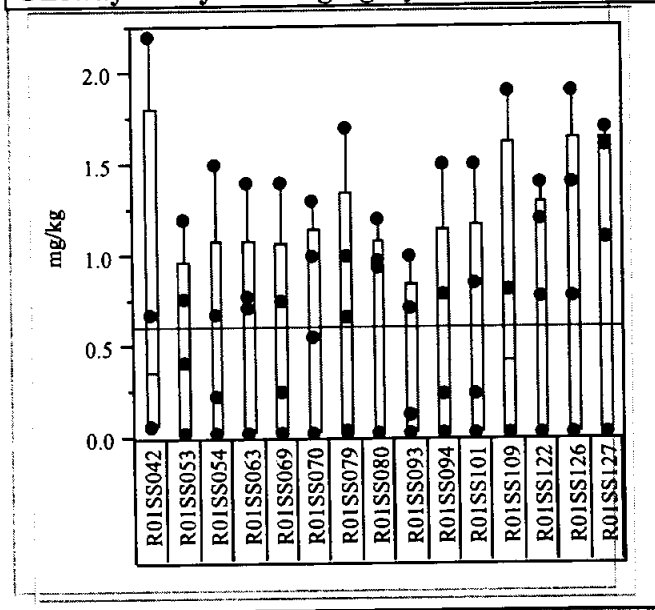
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042	42.80	42.90	19.80	20.40	
R01SS053	17.30	15.90	15.60	15.10	17.10
R01SS054	15.50	15.10	17.00	12.50	11.80
R01SS063	17.80	19.40	15.50	13.20	14.30
R01SS069	15.10	13.00	13.50	13.10	13.50
R01SS070	13.10	14.10	13.20	19.70	12.60
R01SS079	17.60	27.40	14.50	11.90	15.80
R01SS080	13.50	11.10	14.00	13.40	13.80
R01SS093	21.90	15.20	15.30	13.30	18.40
R01SS094	16.10	15.40	14.30	16.40	12.40
R01SS101	12.90	15.40	15.90	14.20	12.10
R01SS109	20.10	23.00	18.80		17.40
R01SS122	18.00	15.70	17.50	11.60	13.00
R01SS126	16.30	13.90	17.20	16.90	13.30
R01SS127	16.60	17.20	14.60	11.70	11.90

Spatial Unit 8, CADMIUM

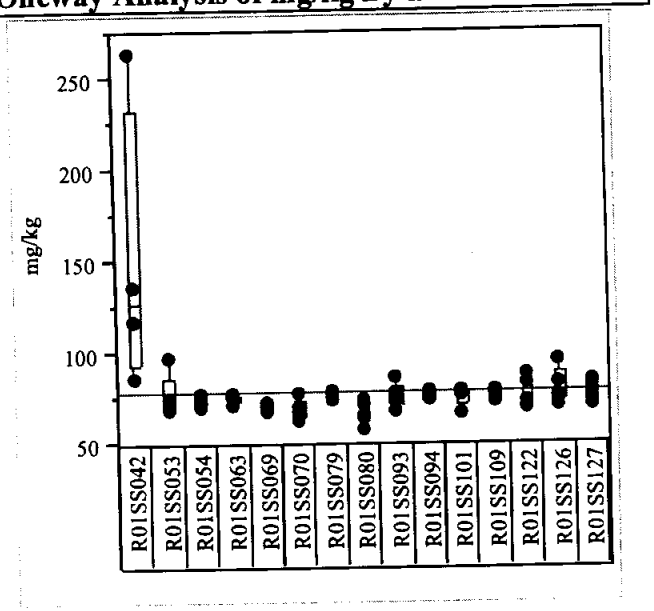
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042	0.07	2.20	0.07	0.67	
R01SS053	0.03	1.20	0.03	0.76	0.41
R01SS054	0.03	1.50	0.03	0.67	0.23
R01SS063	0.03	1.40	0.02	0.71	0.77
R01SS069	0.03	1.40	0.03	0.75	0.25
R01SS070	0.03	1.30	0.02	1.00	0.55
R01SS079	0.03	1.70	0.03	1.00	0.66
R01SS080	0.03	1.20	0.02	0.97	0.94
R01SS093	0.03	0.13	0.03	1.00	0.71
R01SS094	0.03	1.50	0.02	0.79	0.24
R01SS101	0.03	1.50	0.02	0.85	0.24
R01SS109	0.03	1.90	0.03		0.81
R01SS122	0.03	1.40	0.03	0.78	1.20
R01SS126	0.03	1.40	0.02	1.90	0.78
R01SS127	0.03	1.70	0.02	1.60	1.10

Spatial Unit 8, COPPER

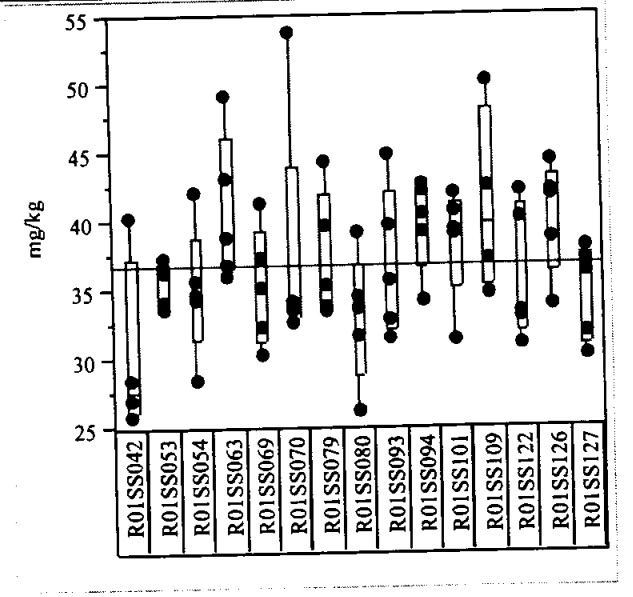
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042	264.00	136.00	86.20	118.00	
R01SS053	72.10	68.50	74.70	72.20	97.10
R01SS054	70.50	73.50	78.00	72.10	74.90
R01SS063	74.90	74.70	77.00	70.70	76.40
R01SS069	69.70	71.50	67.30	70.40	72.90
R01SS070	65.70	70.40	68.00	62.50	77.40
R01SS079	75.90	78.20	75.50	73.80	76.40
R01SS080	64.10	57.70	64.50	71.60	74.30
R01SS093	86.00	67.70	77.10	74.40	72.50
R01SS094	76.60	79.20	76.10	73.70	75.20
R01SS101	79.30	76.90	76.70	66.60	76.40
R01SS109	78.90	76.00	79.10		72.80
R01SS122	72.50	86.90	82.00	68.80	70.30
R01SS126	74.10	75.00	82.30	94.50	70.10
R01SS127	83.20	82.20	77.50	69.80	74.20

Spatial Unit 8, LEAD

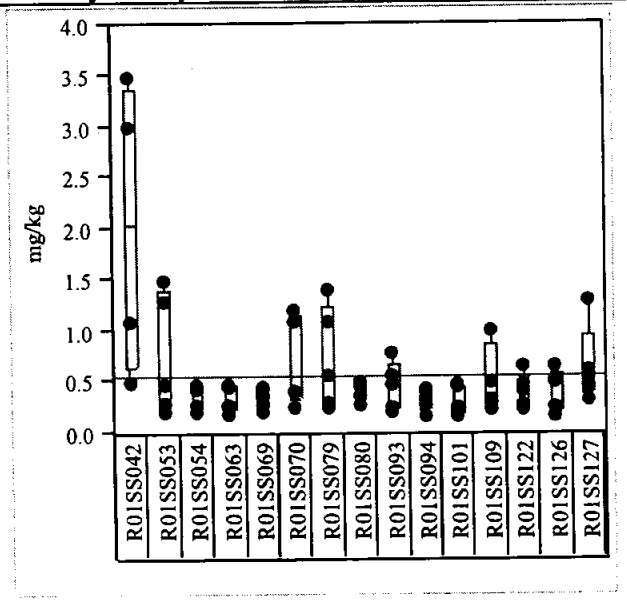
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042	40.30	28.50	27.00	25.80	
R01SS053	36.40	34.20	36.70	37.30	33.60
R01SS054	34.40	34.70	42.10	35.60	28.50
R01SS063	49.10	43.10	38.80	36.90	36.00
R01SS069	41.40	32.30	35.20	30.30	37.30
R01SS070	33.90	33.50	34.10	53.80	32.60
R01SS079	39.70	44.40	35.40	33.80	33.50
R01SS080	31.60	26.10	34.50	39.20	33.70
R01SS093	44.90	31.50	39.60	35.60	32.80
R01SS094	42.60	40.50	42.20	39.20	34.20
R01SS101	39.00	39.30	42.00	40.70	31.30
R01SS109	42.50	37.10	50.10		34.70
R01SS122	40.10	33.00	42.20	31.00	33.40
R01SS126	42.20	38.70	44.40	41.80	33.90
R01SS127	38.00	36.10	37.00	31.90	30.10

Spatial Unit 8, SELENIUM

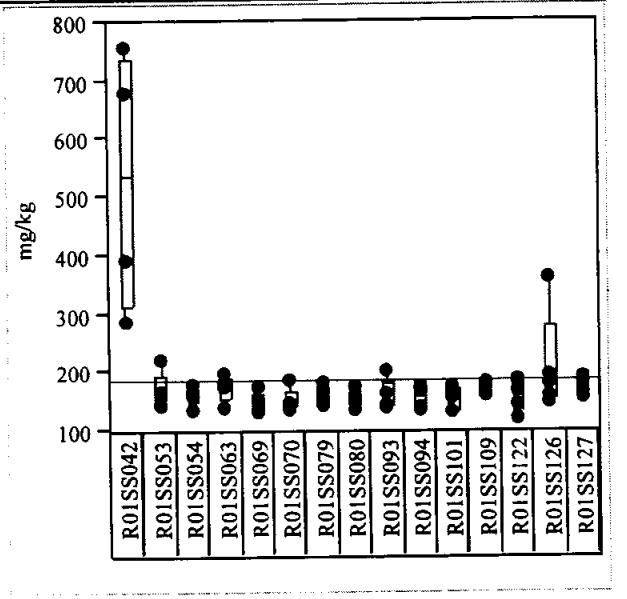
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042	1.10	3.50	0.50	3.00	
R01SS053	0.46	0.29	0.21	1.30	1.50
R01SS054	0.47	0.27	0.20	0.46	0.43
R01SS063	0.47	0.27	0.19	0.45	0.25
R01SS069	0.44	0.28	0.20	0.43	0.35
R01SS070	0.41	0.25	0.41	1.20	1.10
R01SS079	0.55	0.29	0.26	1.40	1.10
R01SS080	0.48	0.26	0.46	0.46	0.36
R01SS093	0.55	0.25	0.20	0.47	0.77
R01SS094	0.42	0.27	0.17	0.41	0.33
R01SS101	0.44	0.25	0.17	0.47	0.21
R01SS109	0.50	0.28	0.22		0.99
R01SS122	0.47	0.27	0.22	0.41	0.64
R01SS126	0.48	0.24	0.17	0.50	0.64
R01SS127	0.55	0.32	0.45	1.30	0.60

Spatial Unit 8, ZINC

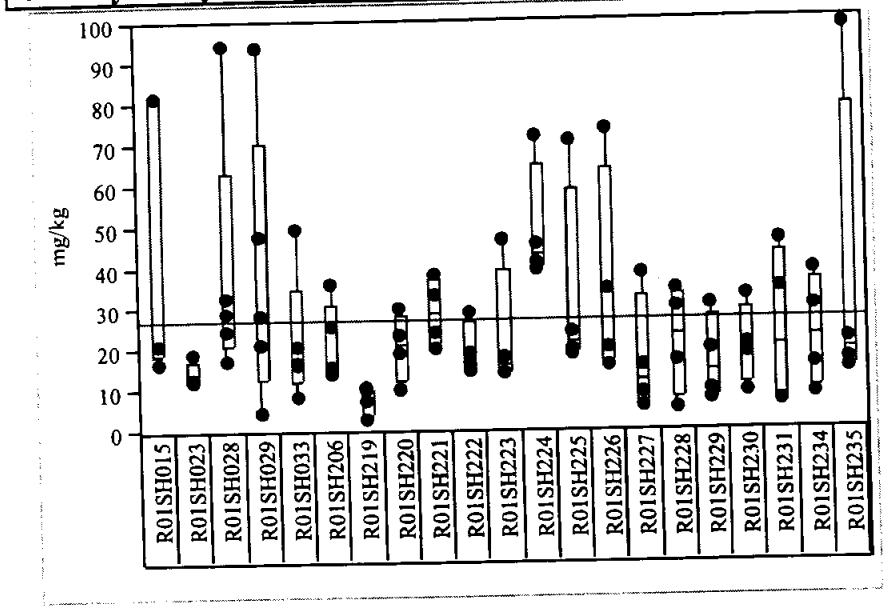
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SS042	678.00	756.00	288.00	392.00	
R01SS053	165.00	161.00	165.00	143.00	222.00
R01SS054	166.00	158.00	177.00	160.00	135.00
R01SS063	173.00	199.00	172.00	138.00	183.00
R01SS069	175.00	149.00	152.00	130.00	133.00
R01SS070	145.00	140.00	147.00	184.00	136.00
R01SS079	168.00	180.00	155.00	141.00	169.00
R01SS080	146.00	134.00	151.00	174.00	159.00
R01SS093	203.00	143.00	163.00	140.00	137.00
R01SS094	172.00	170.00	168.00	137.00	136.00
R01SS101	175.00	155.00	164.00	130.00	133.00
R01SS109	173.00	172.00	183.00		157.00
R01SS122	167.00	182.00	186.00	120.00	143.00
R01SS126	179.00	158.00	195.00	362.00	146.00
R01SS127	182.00	165.00	188.00	155.00	166.00

Spatial Unit 9, ARSENIC

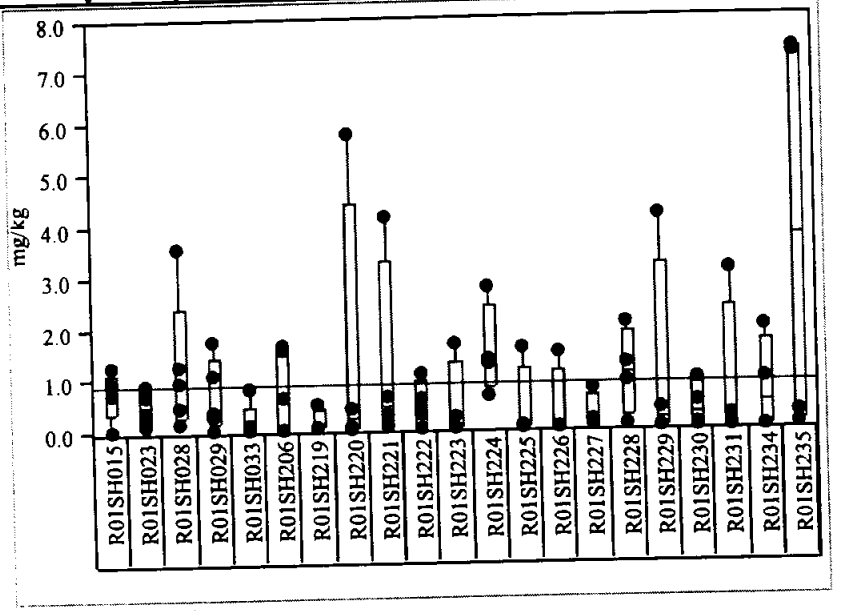
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH015	20.90	16.90	81.90	81.80	21.20
R01SH023	18.80		12.80	12.70	12.10
R01SH028	94.20	29.00	33.00	24.60	17.10
R01SH029	93.70	21.10	28.40	47.60	4.40
R01SH033	20.80	16.60	49.50	16.30	8.60
R01SH206	25.80	14.40	15.60	13.90	35.90
R01SH219		7.00	9.80	10.40	2.70
R01SH220		18.90	23.60	30.20	9.80
R01SH221		20.10	23.80	38.20	33.50
R01SH222		18.90	16.10	29.10	14.20
R01SH223		17.60	14.10	14.10	46.40
R01SH224		40.90	45.70	71.70	39.40
R01SH225		19.20	23.70	70.50	18.50
R01SH226		15.50	73.40	19.80	34.30
R01SH227		38.20	15.80	5.80	8.90
R01SH228		30.00	34.40	16.70	5.10
R01SH229		19.50	30.30	7.50	9.50
R01SH230		20.50	18.30	8.70	32.60
R01SH231		46.10	34.20	6.40	6.90
R01SH234		29.80	38.90	8.20	15.30
R01SH235		21.60	98.10	14.50	16.90

Spatial Unit 9, CADMIUM

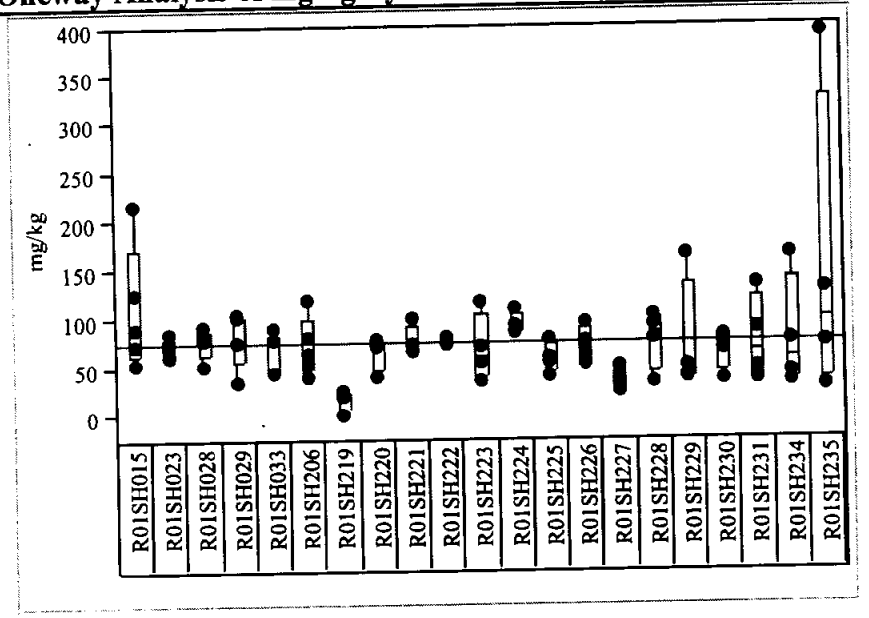
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH015	0.05	0.76	1.30	1.00	1.00
R01SH023	0.69		0.37	0.13	0.94
R01SH028	1.00	1.30	3.60	0.48	0.17
R01SH029	0.30	0.40	1.10	1.80	0.06
R01SH033	0.06	0.83	0.05	0.07	0.15
R01SH206	0.00	1.60	0.04	0.66	1.70
R01SH219		0.54	0.10	0.07	0.10
R01SH220		5.80	0.06	0.43	0.10
R01SH221		0.07	4.20	0.29	0.68
R01SH222		0.33	0.04	0.61	1.10
R01SH223		0.25	0.05	0.05	1.70
R01SH224		1.40	1.30	0.68	2.80
R01SH225		0.07	0.08	0.05	1.60
R01SH226		0.05	0.04	0.05	1.50
R01SH227		0.09	0.11	0.16	0.82
R01SH228		0.08	2.10	1.30	0.92
R01SH229		0.05	4.20	0.03	0.41
R01SH230		0.55	0.08	0.03	1.00
R01SH231		0.26	3.10	0.05	0.09
R01SH234		0.07	2.00	0.06	0.98
R01SH235		0.30	7.40	0.08	7.30

Spatial Unit 9, COPPER

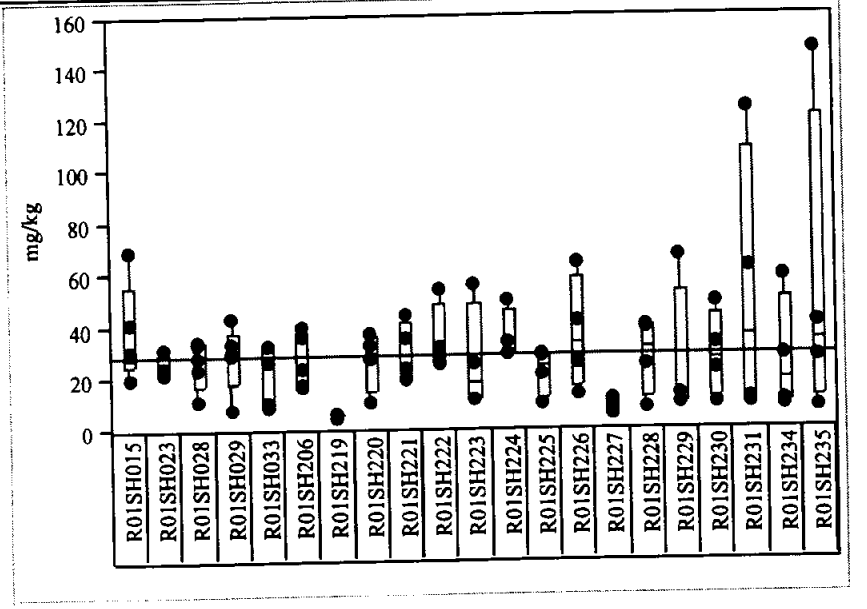
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH015	56.10	75.20	215.00	126.00	91.10
R01SH023	85.20		63.30	69.40	71.80
R01SH028	84.80	82.40	93.70	77.80	53.70
R01SH029	76.10	77.70	102.00	104.00	37.40
R01SH033	77.90	77.80	90.60	47.00	45.40
R01SH206	82.30	64.70	41.20	54.20	119.00
R01SH219		25.80	0.35	20.20	22.30
R01SH220		71.80	78.50	70.70	42.00
R01SH221		67.00	100.00	74.10	67.80
R01SH222		74.80	81.10	82.40	81.20
R01SH223		72.00	37.30	54.40	117.00
R01SH224		84.90	109.00	93.10	92.50
R01SH225		61.10	41.20	55.20	78.00
R01SH226		62.10	94.30	54.00	76.30
R01SH227		50.40	32.50	23.50	36.50
R01SH228		92.80	103.00	78.60	35.00
R01SH229		51.10	163.00	39.20	40.20
R01SH230		66.90	75.90	37.30	82.30
R01SH231		87.90	134.00	36.00	48.30
R01SH234		76.00	163.00	42.30	34.10
R01SH235		73.10	392.00	28.60	128.00

Spatial Unit 9, LEAD

Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH015	20.60	30.60	69.50	42.20	31.30
R01SH023	31.60		25.30	22.60	23.60
R01SH028	33.90	28.70	34.60	24.40	11.40
R01SH029	34.10	29.80	43.20	29.50	7.90
R01SH033	33.30	26.40	32.70	9.00	10.50
R01SH206	36.40	24.40	17.30	17.80	39.60
R01SH219		6.00	4.70	6.10	6.50
R01SH220		27.50	37.30	32.70	10.40
R01SH221		23.80	44.40	35.20	19.20
R01SH222		25.50	54.60	32.20	25.80
R01SH223		26.00	11.40	11.80	56.10
R01SH224		29.20	49.80	33.80	29.30
R01SH225		28.30	10.00	21.20	29.00
R01SH226		25.60	64.30	13.60	41.40
R01SH227		11.60	5.60	6.60	8.70
R01SH228		40.20	39.00	24.70	8.20
R01SH229		13.00	67.00	9.90	10.20
R01SH230		22.70	48.70	9.50	32.50
R01SH231		61.80	124.00	9.60	11.40
R01SH234		28.10	58.40	10.60	9.00
R01SH235		27.20	147.00	7.60	41.30

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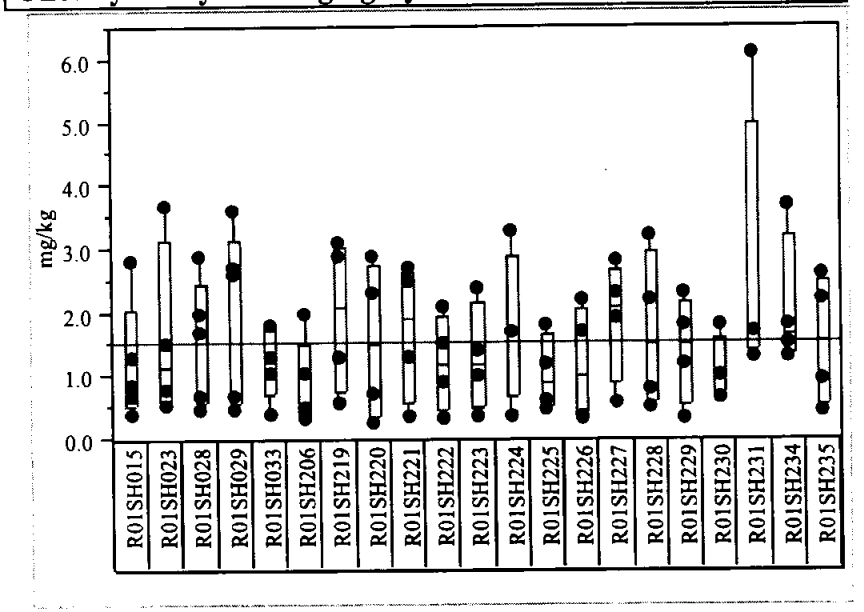
Spatial Unit 9, SELENIUM

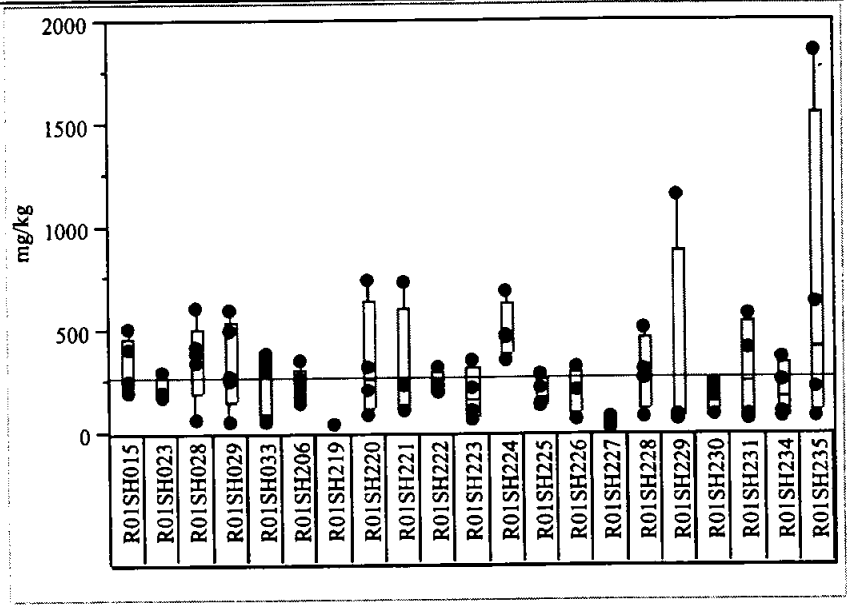
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH015	0.85	1.30	0.39	2.80	0.70
R01SH023	0.80		3.70	1.50	0.55
R01SH028	0.70	0.46	2.90	2.00	1.70
R01SH029	0.70	0.46	3.60	2.60	2.70
R01SH033	1.05	1.80	0.40	1.80	1.30
R01SH206	0.00	0.44	0.33	0.50	2.00
R01SH219		0.59	3.10	1.30	2.90
R01SH220		0.72	2.90	2.30	0.27
R01SH221		2.50	0.35	2.70	1.30
R01SH222		0.90	0.31	2.10	1.50
R01SH223		1.40	0.36	1.00	2.40
R01SH224		1.70	0.35	3.30	1.70
R01SH225		0.48	0.60	1.80	1.20
R01SH226		0.33	0.35	1.70	2.20
R01SH227		0.57	2.30	2.80	1.90
R01SH228		0.52	2.20	3.20	0.80
R01SH229		2.30	0.34	1.80	1.20
R01SH230		1.00	0.65	1.80	1.00
R01SH231		6.10	1.70	1.70	1.30
R01SH234		3.70	1.30	1.80	1.50
R01SH235		2.60	0.44	2.20	0.93

Spatial Unit 9, ZINC

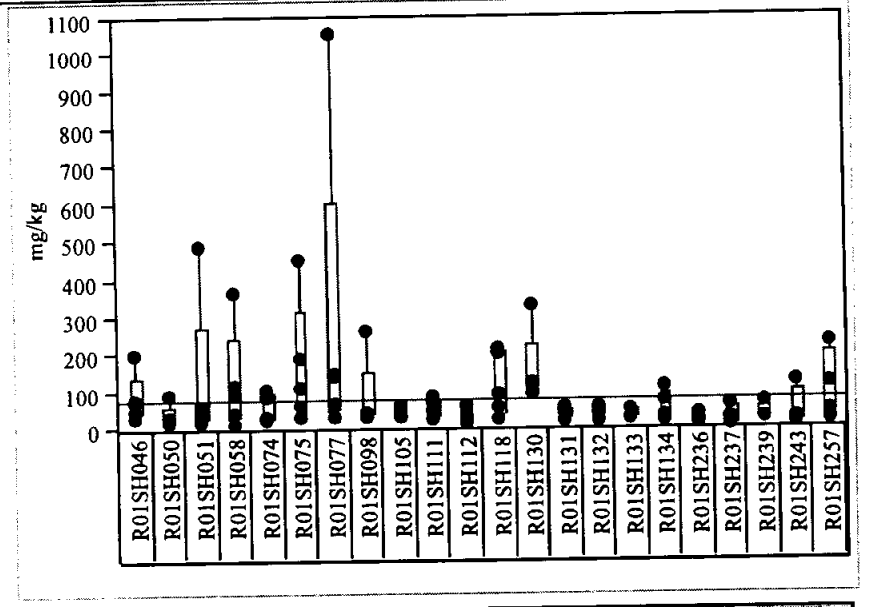
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH015	203.00	259.00	513.00	416.00	241.00
R01SH023	305.00		182.00	194.00	204.00
R01SH028	386.00	419.00	612.00	345.00	65.00
R01SH029	260.00	283.00	496.00	598.00	55.90
R01SH033	367.00	306.00	390.00	66.00	50.80
R01SH206	268.00	147.00	180.00	236.00	356.00
R01SH219		47.20	49.80	45.10	47.80
R01SH220		745.00	326.00	213.00	90.40
R01SH221		229.00	737.00	239.00	106.00
R01SH222		200.00	237.00	319.00	203.00
R01SH223		222.00	107.00	65.80	361.00
R01SH224		478.00	360.00	690.00	472.00
R01SH225		223.00	131.00	143.00	287.00
R01SH226		208.00	324.00	70.60	211.00
R01SH227		22.80	60.00	58.60	79.00
R01SH228		309.00	512.00	267.00	76.30
R01SH229		72.00	1,160.00	86.50	77.00
R01SH230		246.00	174.00	89.70	198.00
R01SH231		414.00	582.00	91.70	64.70
R01SH234		259.00	367.00	100.00	76.90
R01SH235		225.00	1,860.00	79.90	628.00

Spatial Unit 10, ARSENIC

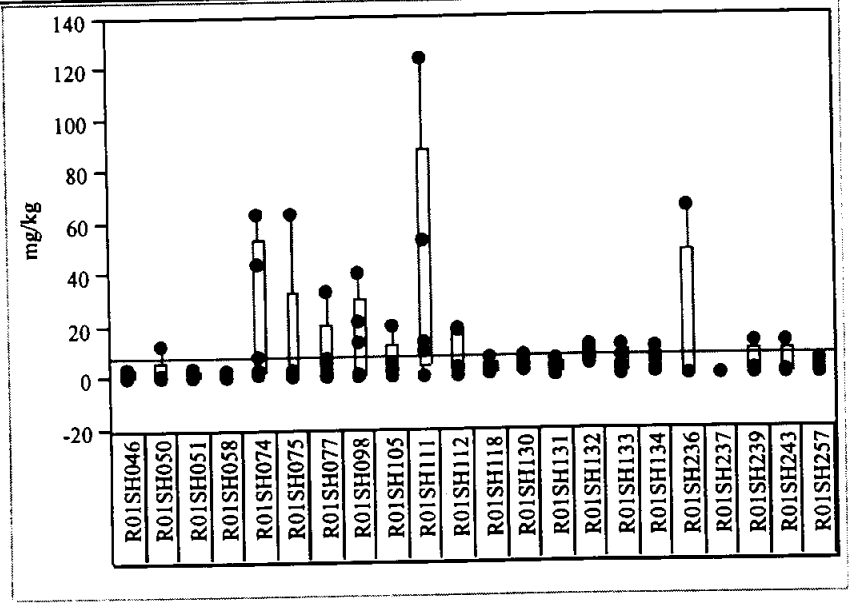
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH046	79.50	29.90	204.00	75.70	49.80
R01SH050	91.60	31.20	33.30	23.40	15.50
R01SH051	487.00	21.10	62.30	22.90	42.90
R01SH058	43.00	13.20	115.00	368.00	91.10
R01SH074	103.00	25.70	28.60	87.10	25.00
R01SH075	59.30	27.60	187.00	451.00	107.00
R01SH077	138.00	67.60	144.00	1,060.00	32.80
R01SH098	36.20	45.50	32.00	265.00	43.50
R01SH105	44.20	27.70	32.10	58.30	62.30
R01SH111	86.70	47.20	21.80	66.20	43.90
R01SH112	53.40	10.90	19.70	60.70	28.50
R01SH118	54.90	212.00	91.90	202.00	24.20
R01SH130	89.70	331.00	114.00	93.50	123.00
R01SH131	35.30	16.90	40.60	48.30	52.50
R01SH132	55.00	37.70	48.30	19.80	37.90
R01SH133	49.50	26.20	26.50	25.80	46.30
R01SH134	70.50	18.20	113.00	32.10	27.30
R01SH236		21.20	35.30	15.10	12.80
R01SH237		26.60	3.60	61.50	15.00
R01SH239		21.80	25.70	22.80	66.30
R01SH243		17.20	26.00	124.00	10.30
R01SH257		20.70	115.00	45.40	228.00

Spatial Unit 10, CADMIUM

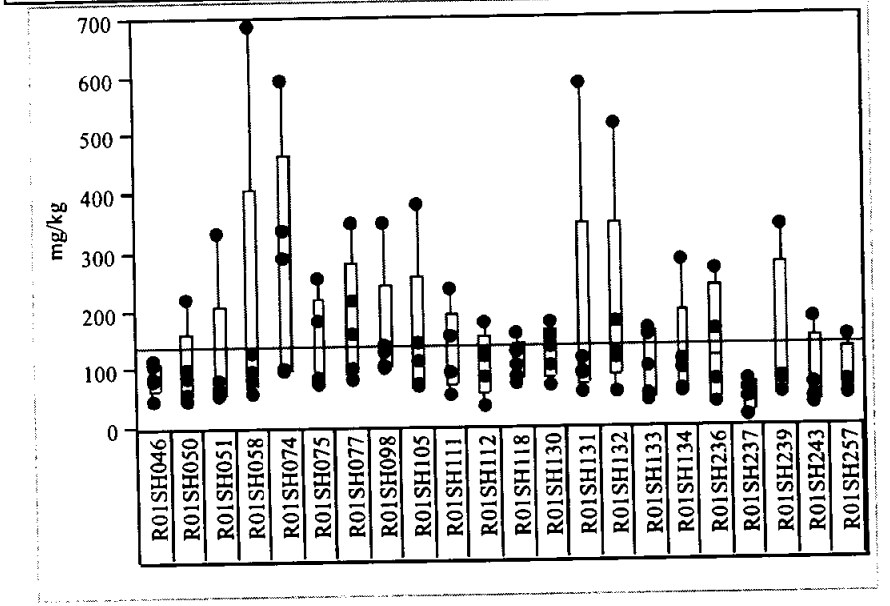
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH046	1.50	3.90	3.50	0.17	0.54
R01SH050	13.10	0.92	0.04	0.05	0.84
R01SH051	4.10	0.07	0.04	0.06	2.00
R01SH058	2.80	0.06	1.60	1.50	0.71
R01SH074	63.40	1.30	3.50	8.20	44.00
R01SH075	63.80	0.90	3.00	0.38	3.50
R01SH077	33.50	5.70	7.70	0.37	1.50
R01SH098	0.06	1.60	40.40	21.50	13.50
R01SH105	0.79	2.40	3.10	20.30	5.70
R01SH111	52.60	9.90	0.07	13.40	124.00
R01SH112	3.60	0.09	3.00	17.90	19.10
R01SH118	7.60	1.00	4.10	1.90	3.10
R01SH130	3.80	8.40	5.00	2.50	7.00
R01SH131	4.00	0.29	7.10	2.80	2.20
R01SH132	7.60	10.20	12.10	5.10	7.00
R01SH133	12.20	0.04	2.20	4.40	7.40
R01SH134	7.20	1.60	2.40	11.30	6.10
R01SH236		0.05	0.18	0.06	64.90
R01SH237		0.26	0.09	0.07	0.71
R01SH239		0.06	2.00	0.05	13.10
R01SH243		0.97	1.10	12.90	0.04
R01SH257		0.19	5.80	0.05	0.98

Spatial Unit 10, COPPER

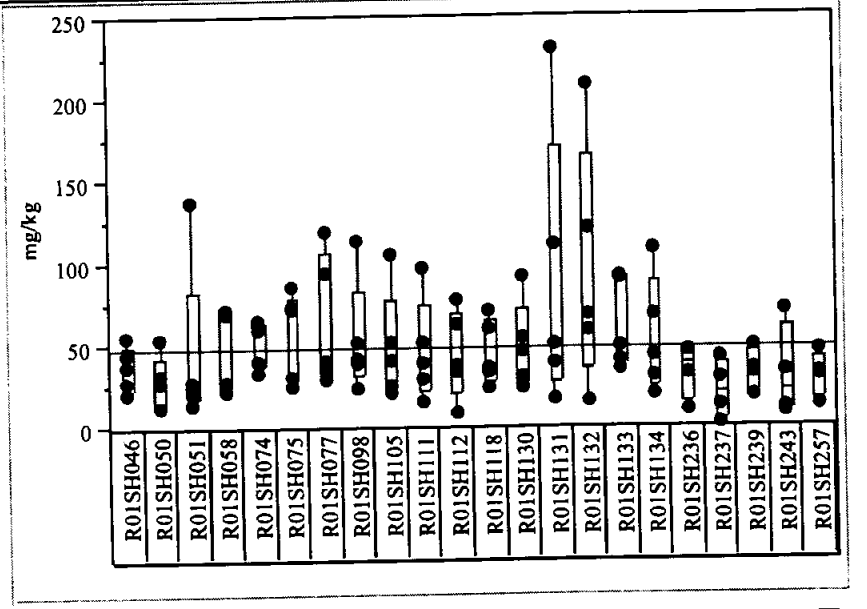
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH046	82.50	84.30	118.00	107.00	47.80
R01SH050	222.00	83.70	101.00	48.50	57.60
R01SH051	336.00	65.50	59.60	53.10	82.30
R01SH058	82.10	56.60	128.00	689.00	98.50
R01SH074	291.00	99.40	95.70	596.00	340.00
R01SH075	258.00	85.00	184.00	82.10	75.30
R01SH077	219.00	161.00	351.00	83.60	99.70
R01SH098	99.50	104.00	351.00	140.00	129.00
R01SH105	381.00	75.30	69.60	144.00	112.00
R01SH111	154.00	92.00	55.20	94.20	238.00
R01SH112	129.00	33.50	86.10	179.00	121.00
R01SH118	129.00	159.00	86.90	105.00	75.20
R01SH130	69.50	155.00	105.00	180.00	135.00
R01SH131	586.00	116.00	93.40	89.90	56.70
R01SH132	125.00	118.00	180.00	59.30	518.00
R01SH133	169.00	42.70	53.20	102.00	157.00
R01SH134	284.00	97.60	61.80	58.60	112.00
R01SH236		78.70	162.00	38.50	268.00
R01SH237		76.60	14.20	63.20	48.50
R01SH239		79.00	80.90	54.50	344.00
R01SH243		48.30	70.90	181.00	33.40
R01SH257		73.60	150.00	51.20	55.30

Spatial Unit 10, LEAD

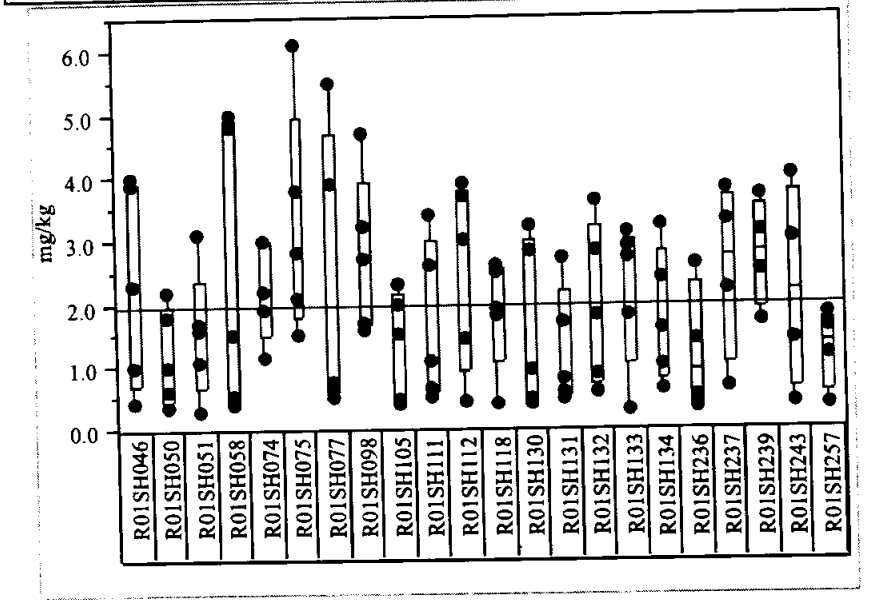
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH046	37.70	28.20	56.10	44.40	20.30
R01SH050	54.60	31.70	27.20	12.10	12.80
R01SH051	138.00	28.20	14.30	20.50	24.90
R01SH058	28.20	22.40	68.80	72.60	27.80
R01SH074	62.70	34.00	40.00	59.40	65.60
R01SH075	73.30	31.10	85.80	72.20	25.60
R01SH077	34.90	40.80	120.00	94.00	29.80
R01SH098	41.80	39.40	114.00	51.60	23.30
R01SH105	105.00	20.90	25.10	51.20	40.60
R01SH111	51.70	29.30	15.90	38.40	97.80
R01SH112	38.00	8.40	33.20	77.50	62.10
R01SH118	59.40	70.50	36.00	33.00	23.20
R01SH130	23.50	46.40	54.40	91.10	30.60
R01SH131	231.00	111.00	49.70	39.10	16.80
R01SH132	68.70	58.20	121.00	14.70	209.00
R01SH133	91.90	39.90	34.10	48.40	90.30
R01SH134	109.00	67.90	30.60	19.90	42.60
R01SH236		31.70	45.20	9.10	46.00
R01SH237		29.50	1.70	41.20	12.20
R01SH239		35.00	31.40	17.80	49.20
R01SH243		11.20	33.90	70.40	8.60
R01SH257		31.70	45.40	12.90	30.20

Spatial Unit 10, SELENIUM

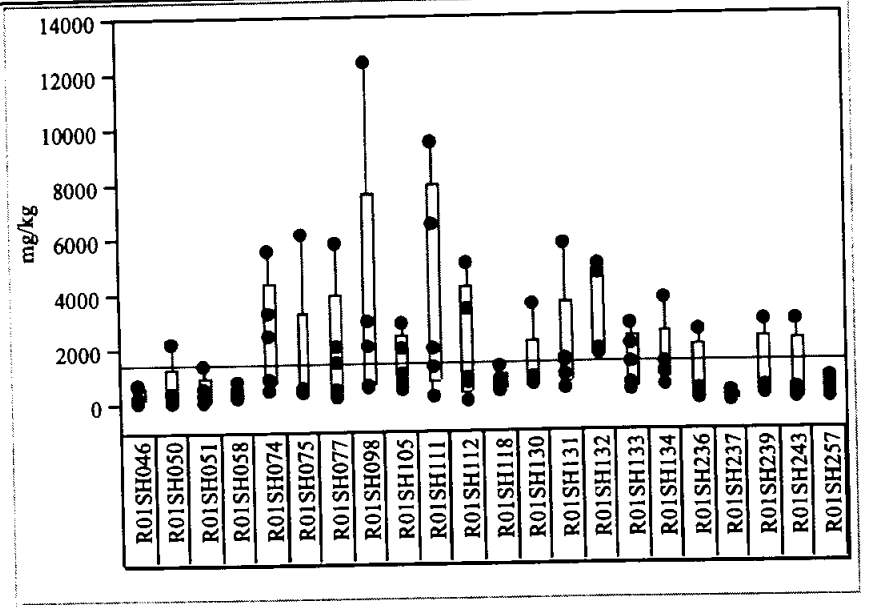
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH046	0.44	2.30	3.90	4.00	1.00
R01SH050	1.00	1.80	0.35	2.20	0.60
R01SH051	1.10	1.60	0.30	3.10	1.70
R01SH058	0.55	0.40	5.00	4.80	1.50
R01SH074	1.15	3.00	3.00	2.20	1.90
R01SH075	2.10	2.80	6.10	3.80	1.50
R01SH077	0.75	0.50	5.50	3.90	0.65
R01SH098	3.20	2.70	4.70	1.70	1.60
R01SH105	1.50	0.48	0.41	2.00	2.30
R01SH111	0.65	1.10	0.50	3.40	2.60
R01SH112	1.45	3.70	0.43	3.90	3.00
R01SH118	2.50	2.60	0.38	1.80	1.90
R01SH130	0.48	2.80	0.41	3.20	0.95
R01SH131	2.70	0.57	0.47	1.70	0.80
R01SH132	3.60	0.56	2.80	0.88	1.80
R01SH133	3.10	1.80	0.28	2.90	2.70
R01SH134	0.60	3.20	1.00	1.60	2.40
R01SH236		0.34	1.40	2.60	0.49
R01SH237		2.20	0.65	3.80	3.30
R01SH239		3.10	3.70	2.50	1.70
R01SH243		1.40	3.00	4.00	0.41
R01SH257		0.38	1.15	1.60	1.80

Spatial Unit 10, ZINC

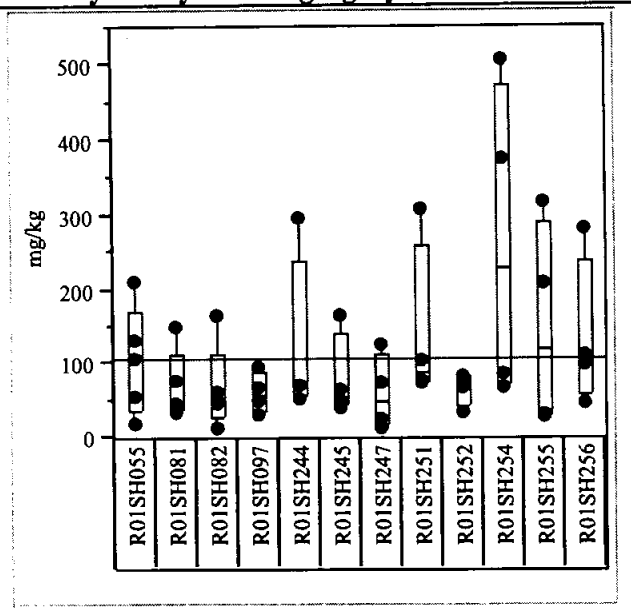
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH046	182.00	627.00	740.00	271.00	119.00
R01SH050	2,250.00	429.00	233.00	69.40	68.60
R01SH051	1,400.00	312.00	87.40	75.50	595.00
R01SH058	508.00	233.00	346.00	844.00	256.00
R01SH074	2,460.00	527.00	910.00	3,300.00	5,580.00
R01SH075	6,140.00	410.00	543.00	402.00	532.00
R01SH077	5,840.00	1,470.00	2,110.00	286.00	483.00
R01SH098	612.00	696.00	12,400.00	3,000.00	2,050.00
R01SH105	2,030.00	656.00	530.00	2,890.00	1,070.00
R01SH111	6,480.00	1,360.00	240.00	2,000.00	9,500.00
R01SH112	944.00	69.80	779.00	3,380.00	5,050.00
R01SH118	1,330.00	612.00	733.00	873.00	456.00
R01SH130	925.00	3,580.00	851.00	664.00	881.00
R01SH131	5,750.00	1,480.00	1,620.00	1,030.00	539.00
R01SH132	1,840.00	1,740.00	4,970.00	1,890.00	4,700.00
R01SH133	2,860.00	401.00	679.00	1,380.00	2,050.00
R01SH134	3,740.00	1,010.00	599.00	1,390.00	1,120.00
R01SH236		241.00	426.00	89.20	2,590.00
R01SH237		313.00	0.13	203.00	148.00
R01SH239		348.00	502.00	256.00	2,920.00
R01SH243		250.00	429.00	2,880.00	76.10
R01SH257		423.00	835.00	113.00	182.00

Spatial Unit 11, ARSENIC

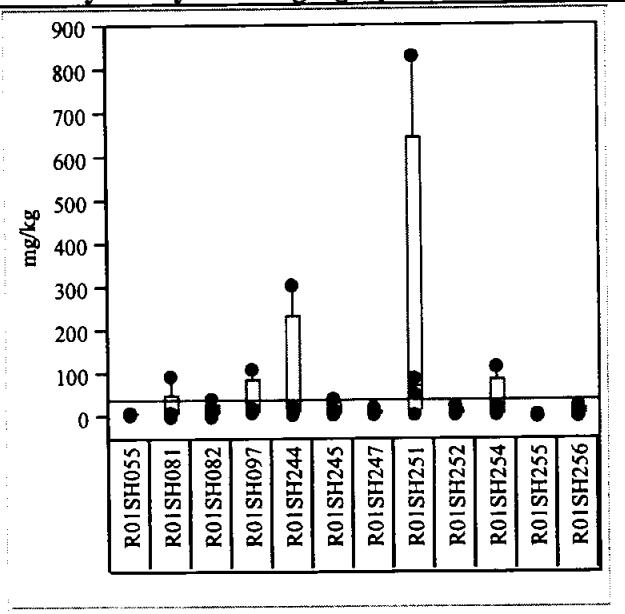
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH055	131.00	18.90	107.00	210.00	56.10
R01SH081	75.80	33.60	149.00	46.40	40.40
R01SH082	50.20	44.90	166.00	12.60	59.70
R01SH097	30.00		47.80	95.10	66.60
R01SH244		50.70	295.00	70.40	69.60
R01SH245		63.60	165.00	47.40	40.10
R01SH247		24.60	13.60	124.00	74.60
R01SH251		72.30	310.00	103.00	76.30
R01SH252		34.10	81.90	79.50	67.10
R01SH254		66.00	375.00	508.00	84.20
R01SH255		208.00	27.60	317.00	30.60
R01SH256		281.00	110.00	96.60	47.20

Spatial Unit 11, CADMIUM

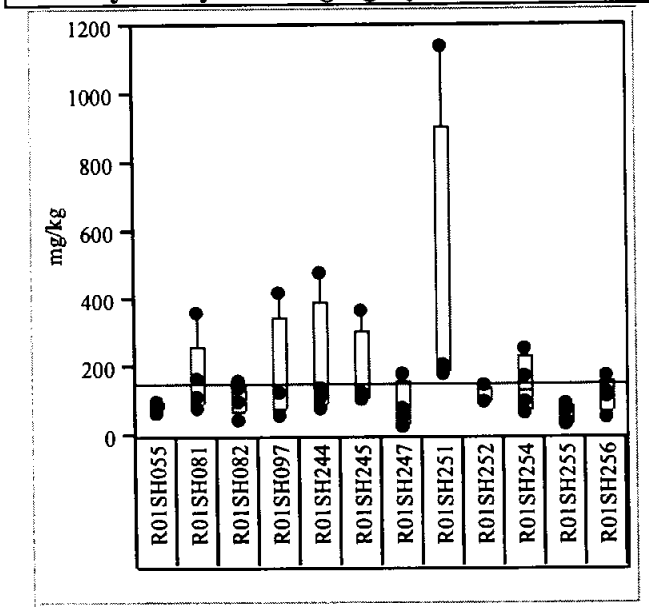
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH055	2.10	0.63	4.60	3.50	8.20
R01SH081	0.08	0.81	94.00	6.80	7.70
R01SH082	13.90	4.90	37.70	0.03	20.50
R01SH097	7.50		20.50	108.00	10.40
R01SH244		2.70	304.00	25.40	16.60
R01SH245		2.40	40.10	11.30	7.90
R01SH247		1.30	2.20	18.70	5.70
R01SH251		1.90	832.00	52.60	88.70
R01SH252		2.30	2.50	21.80	16.80
R01SH254		26.10	4.80	1.40	111.00
R01SH255		1.60	0.05	3.50	2.40
R01SH256		0.80	0.05	12.50	22.50

Spatial Unit 11, COPPER

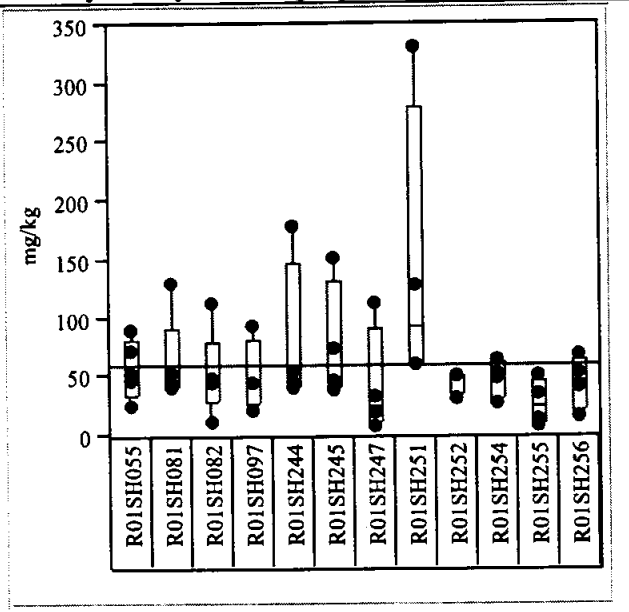
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH055	95.40	67.00	100.00	89.20	96.00
R01SH081	165.00	77.90	357.00	112.00	112.00
R01SH082	137.00	100.00	159.00	45.10	145.00
R01SH097	61.40		126.00	423.00	124.00
R01SH244		82.80	479.00	112.00	137.00
R01SH245		126.00	367.00	116.00	105.00
R01SH247		53.80	24.90	183.00	78.60
R01SH251		208.00	1,140.00	180.00	197.00
R01SH252		97.40	102.00	103.00	149.00
R01SH254		171.00	67.80	96.90	253.00
R01SH255		70.50	32.40	91.20	42.70
R01SH256		114.00	55.60	129.00	172.00

Spatial Unit 11, LEAD

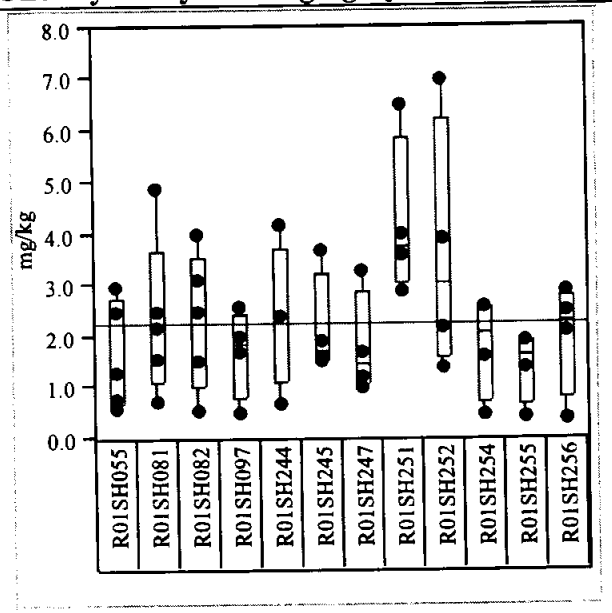
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH055	72.40	24.90	90.00	47.00	52.80
R01SH081	52.90	43.10	130.00	40.40	44.80
R01SH082	49.10	45.00	112.00	11.80	46.10
R01SH097	22.20		45.50	93.00	44.40
R01SH244		40.30	178.00	44.50	54.60
R01SH245		73.80	152.00	46.80	39.80
R01SH247		32.10	7.60	112.00	20.00
R01SH251		128.00	331.00	59.80	59.90
R01SH252		50.60	31.10	50.50	51.40
R01SH254		53.10	26.70	47.70	64.60
R01SH255		34.60	8.00	50.50	14.50
R01SH256		67.30	15.00	41.80	52.10

Spatial Unit 11, SELENIUM

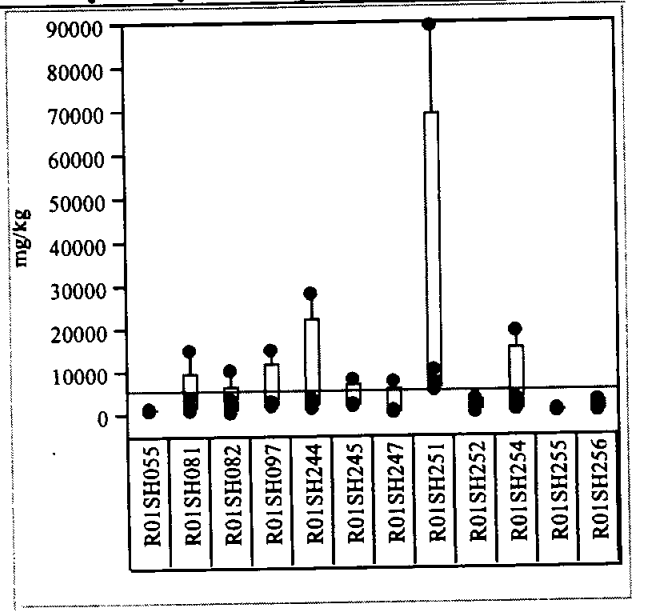
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH055	1.30	0.75	0.60	3.00	2.50
R01SH081	1.55	0.70	4.90	2.20	2.50
R01SH082	2.50	4.00	0.55	1.50	3.10
R01SH097	2.00		0.50	2.60	1.70
R01SH244		0.66	4.20	2.40	2.40
R01SH245		3.70	1.60	1.90	1.50
R01SH247		1.20	1.00	3.30	1.70
R01SH251		6.50	3.60	2.90	4.00
R01SH252		3.90	7.00	2.20	1.40
R01SH254		2.60	0.44	2.60	1.60
R01SH255		1.90	0.40	1.90	1.40
R01SH256		2.50	0.36	2.10	2.90

Spatial Unit 11, ZINC

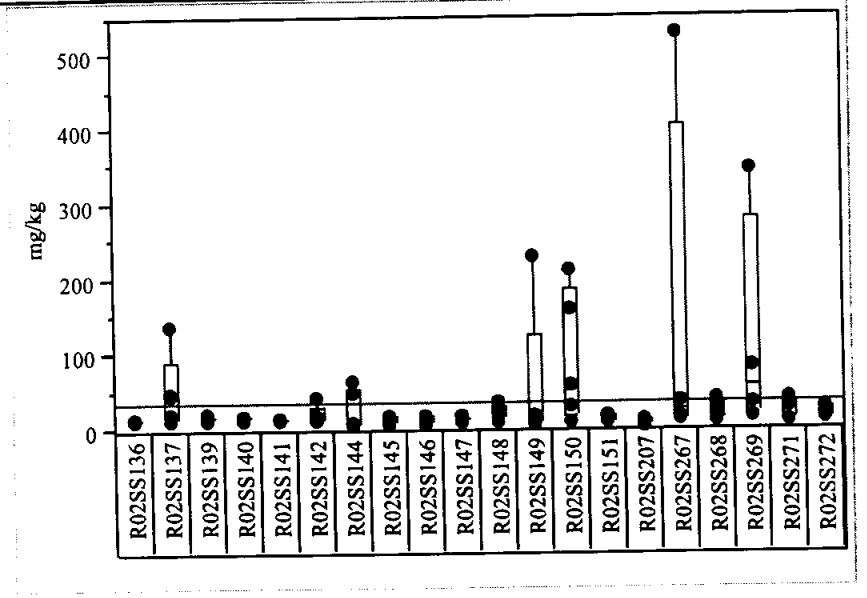
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R01SH055	953.00	581.00	1,410.00	1,250.00	1,380.00
R01SH081	4,210.00	961.00	15,000.00	1,890.00	1,510.00
R01SH082	2,920.00	1,440.00	10,100.00	381.00	3,640.00
R01SH097	1,780.00		3,040.00	15,000.00	2,070.00
R01SH244		1,270.00	28,500.00	2,900.00	3,310.00
R01SH245		2,320.00	8,420.00	2,290.00	1,710.00
R01SH247		495.00	446.00	7,770.00	692.00
R01SH251		5,560.00	89,300.00	7,260.00	10,200.00
R01SH252		1,230.00	526.00	3,630.00	3,410.00
R01SH254		3,460.00	744.00	1,630.00	19,500.00
R01SH255		477.00	97.40	613.00	434.00
R01SH256		440.00	133.00	2,510.00	2,980.00

Spatial Unit 12, ARSENIC

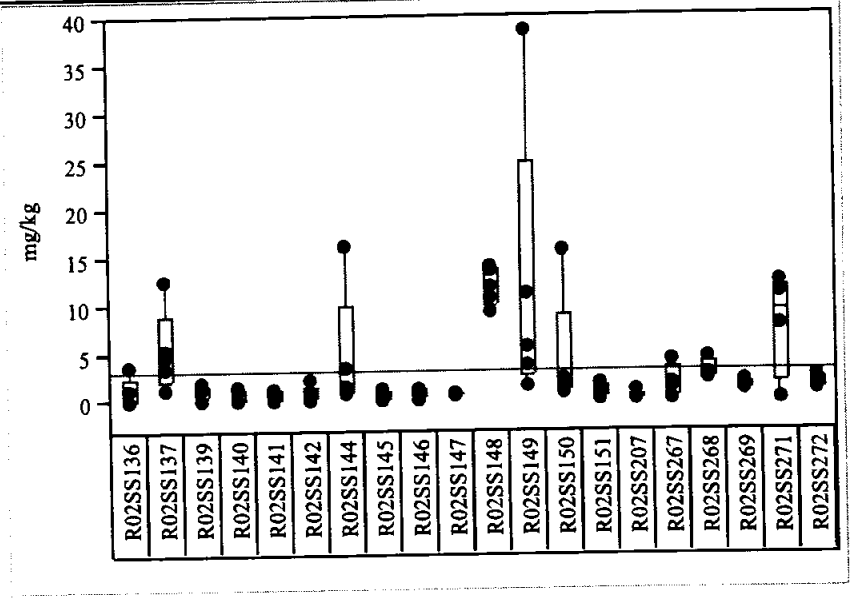
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R02SS136	13.80	16.10	14.00	12.50	12.70
R02SS137	10.80	137.00	46.40	47.60	21.10
R02SS139	18.10	17.90	16.50	13.60	20.70
R02SS140	17.30	16.00	16.60	12.20	16.60
R02SS141	16.10	14.70	13.30	11.10	13.30
R02SS142	43.50	17.50	14.30	11.80	14.00
R02SS144	7.90	48.20	63.60	6.30	7.80
R02SS145	17.40	16.10	16.50	7.20	13.30
R02SS146	5.80	16.50	15.20	12.80	18.10
R02SS147	17.10	11.80	13.30	14.30	10.60
R02SS148	27.40	24.90	36.70	10.00	22.40
R02SS149	5.00	17.90	230.00	18.40	11.00
R02SS150	212.00	58.70	31.40	8.30	158.00
R02SS151	7.70	19.30	14.30	8.70	18.30
R02SS207	11.60	9.00	6.80	3.90	13.60
R02SS267		11.60	36.80	16.40	528.00
R02SS268		19.30	29.50	40.60	10.00
R02SS269		35.00	16.80	346.00	82.30
R02SS271		8.10	33.60	38.20	27.10
R02SS272		28.10	19.80	15.60	11.50

Spatial Unit 12, CADMIUM

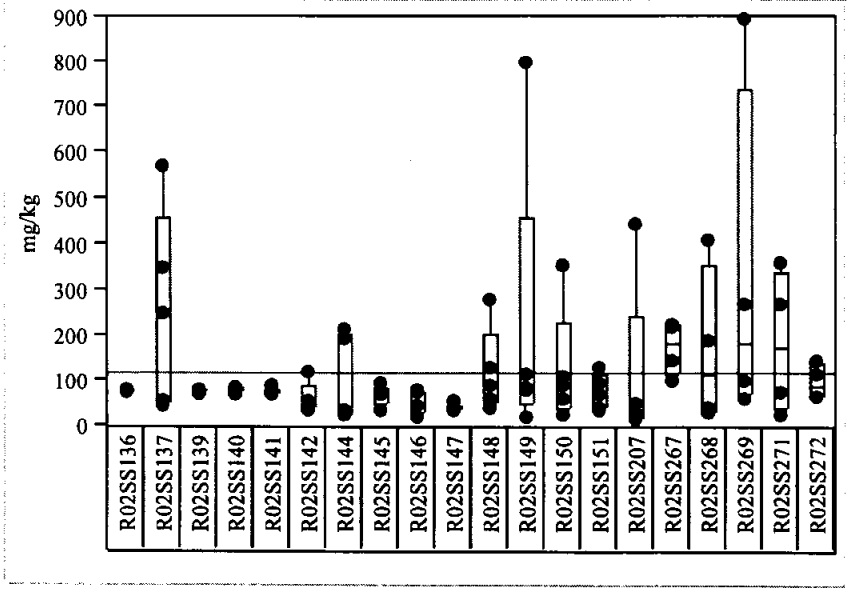
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R02SS136	0.03	1.20	0.02	1.30	3.80
R02SS137	1.20	12.50	4.70	3.40	5.40
R02SS139	0.03	1.60	1.40	1.30	2.10
R02SS140	0.03	1.30	0.02	1.50	0.97
R02SS141	0.03	1.20	0.02	1.20	0.92
R02SS142	2.30	0.02	0.96	0.85	1.00
R02SS144	16.10	1.50	3.50	0.81	0.76
R02SS145	0.02	0.13	0.73	0.27	1.20
R02SS146	0.02	1.20	0.65	1.20	1.40
R02SS147	0.78	0.93	0.87	0.74	0.65
R02SS148	14.00	10.60	11.70	9.20	13.40
R02SS149	3.80	11.10	38.60	1.50	5.60
R02SS150	15.60	1.20	2.20	0.92	2.10
R02SS151	0.53	1.80	0.79	0.05	1.30
R02SS207	0.02	0.02	0.02	0.04	0.95
R02SS267		4.10	0.05	1.70	1.20
R02SS268		2.20	4.30	2.80	2.60
R02SS269		1.90	1.40	1.10	1.10
R02SS271		0.02	12.20	7.70	11.10
R02SS272		2.50	1.70	1.20	0.96

Spatial Unit 12, COPPER

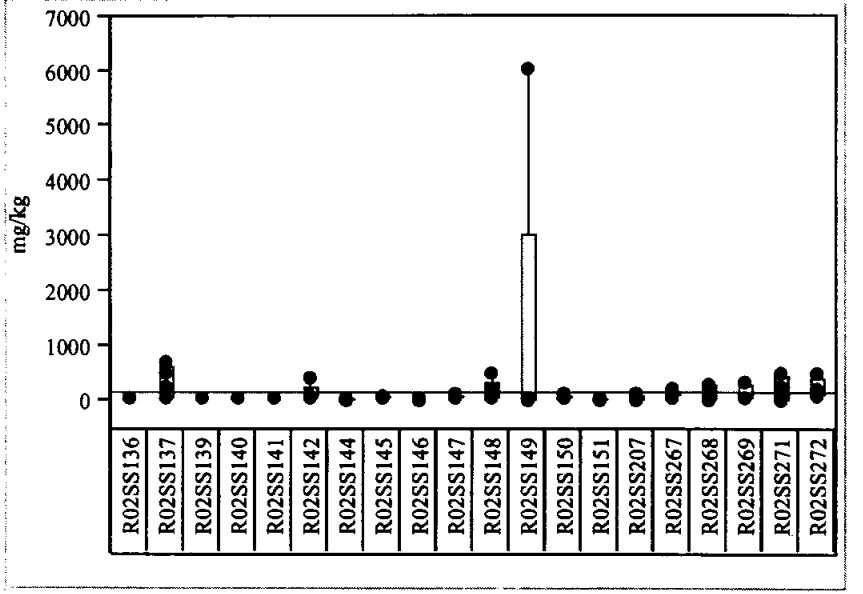
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R02SS136	73.50	79.40	73.40	75.80	76.10
R02SS137	42.70	572.00	252.00	352.00	53.50
R02SS139	76.10	78.90	80.10	76.20	72.00
R02SS140	84.50	74.70	83.90	79.00	72.00
R02SS141	89.00	72.00	67.70	74.60	74.10
R02SS142	121.00	54.70	41.10	36.30	44.30
R02SS144	25.80	193.00	217.00	23.00	32.90
R02SS145	71.20	80.50	93.00	33.40	73.80
R02SS146	19.80	77.60	76.60	72.80	43.80
R02SS147	53.80	32.90	36.50	38.20	33.00
R02SS148	130.00	280.00	90.10	60.10	41.40
R02SS149	18.80	87.00	802.00	80.10	115.00
R02SS150	355.00	58.20	109.00	24.50	89.80
R02SS151	35.20	96.80	67.60	41.90	129.00
R02SS207	47.70	28.10	19.20	13.40	443.00
R02SS267		147.00	227.00	102.00	221.00
R02SS268		42.10	191.00	411.00	29.30
R02SS269		99.70	61.40	894.00	269.00
R02SS271		26.50	272.00	362.00	73.40
R02SS272		146.00	114.00	67.40	63.00

Spatial Unit 12, LEAD

Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R02SS136	36.90	36.70	38.80	37.70	33.50
R02SS137	24.20	724.00	491.00	255.00	36.50
R02SS139	45.70	37.00	39.50	43.10	34.50
R02SS140	38.20	37.00	45.90	36.00	32.70
R02SS141	40.40	30.60	33.40	31.70	32.40
R02SS142	414.00	59.60	67.00	62.90	43.80
R02SS144	8.20	27.50	50.20	30.70	15.20
R02SS145	41.20	35.00	51.70	102.00	31.40
R02SS146	10.60	34.90	43.00	33.00	62.20
R02SS147	121.00	60.50	58.40	58.10	48.90
R02SS148	190.00	491.00	79.80	137.00	26.00
R02SS149	6.80	14.20	6,060.00	37.80	9.50
R02SS150	140.00	60.30	32.10	26.80	54.10
R02SS151	17.30	41.40	59.70	23.60	37.90
R02SS207	37.00	18.80	13.40	7.90	144.00
R02SS267		93.80	204.00	59.90	102.00
R02SS268		23.30	255.00	300.00	7.80
R02SS269		52.60	48.60	345.00	29.70
R02SS271		6.80	266.00	509.00	61.70
R02SS272		480.00	229.00	148.00	66.20

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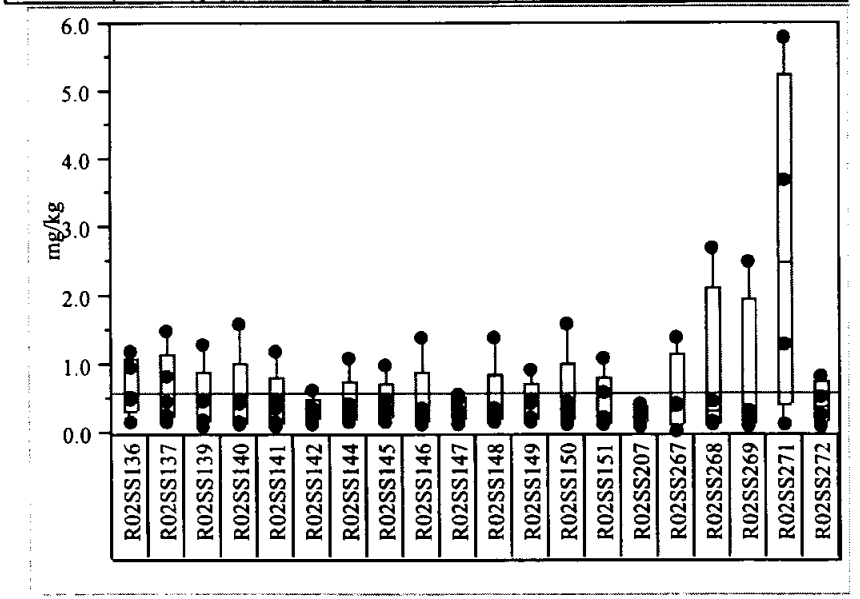
Spatial Unit 12, SELENIUM

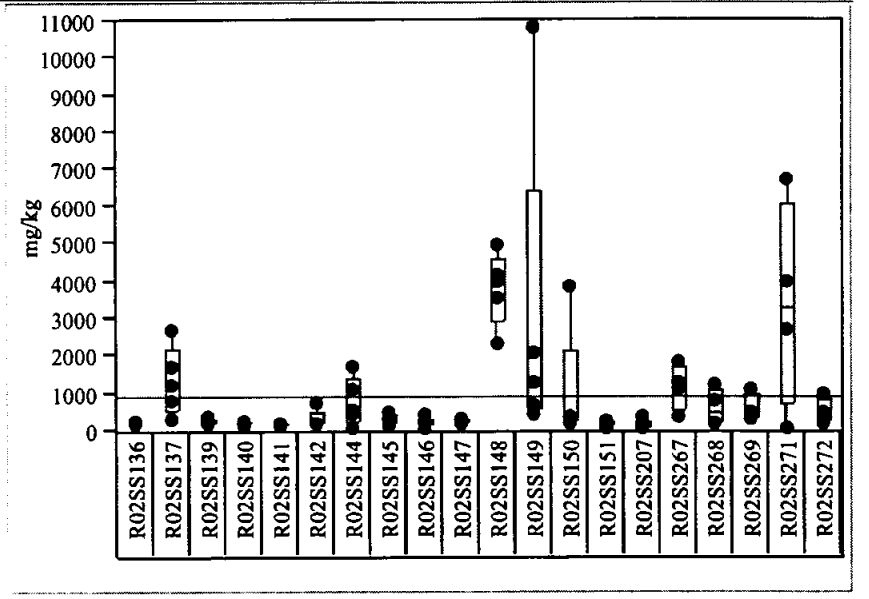
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R02SS136	0.49	0.97	0.18	1.20	0.55
R02SS137	0.48	0.85	0.18	1.50	0.28
R02SS139	0.47	0.11	0.20	1.30	0.50
R02SS140	0.45	0.13	0.18	1.60	0.50
R02SS141	0.50	0.11	0.18	1.20	0.37
R02SS142	0.36	0.14	0.33	0.62	0.28
R02SS144	0.43	0.25	0.17	1.10	0.34
R02SS145	0.37	0.30	0.16	1.00	0.50
R02SS146	0.37	0.13	0.18	1.40	0.23
R02SS147	0.35	0.15	0.50	0.56	0.28
R02SS148	0.36	0.27	0.16	1.40	0.27
R02SS149	0.43	0.25	0.17	0.95	0.49
R02SS150	0.35	0.15	1.60	0.26	0.48
R02SS151	0.25	0.12	0.16	1.10	0.60
R02SS207	0.35	0.23	0.34	0.11	0.45
R02SS267		0.04	0.40	1.40	0.42
R02SS268		0.12	0.48	2.70	0.16
R02SS269		0.11	0.17	2.50	0.34
R02SS271		0.13	3.70	5.80	1.30
R02SS272		0.12	0.52	0.85	0.28

Spatial Unit 12, ZINC

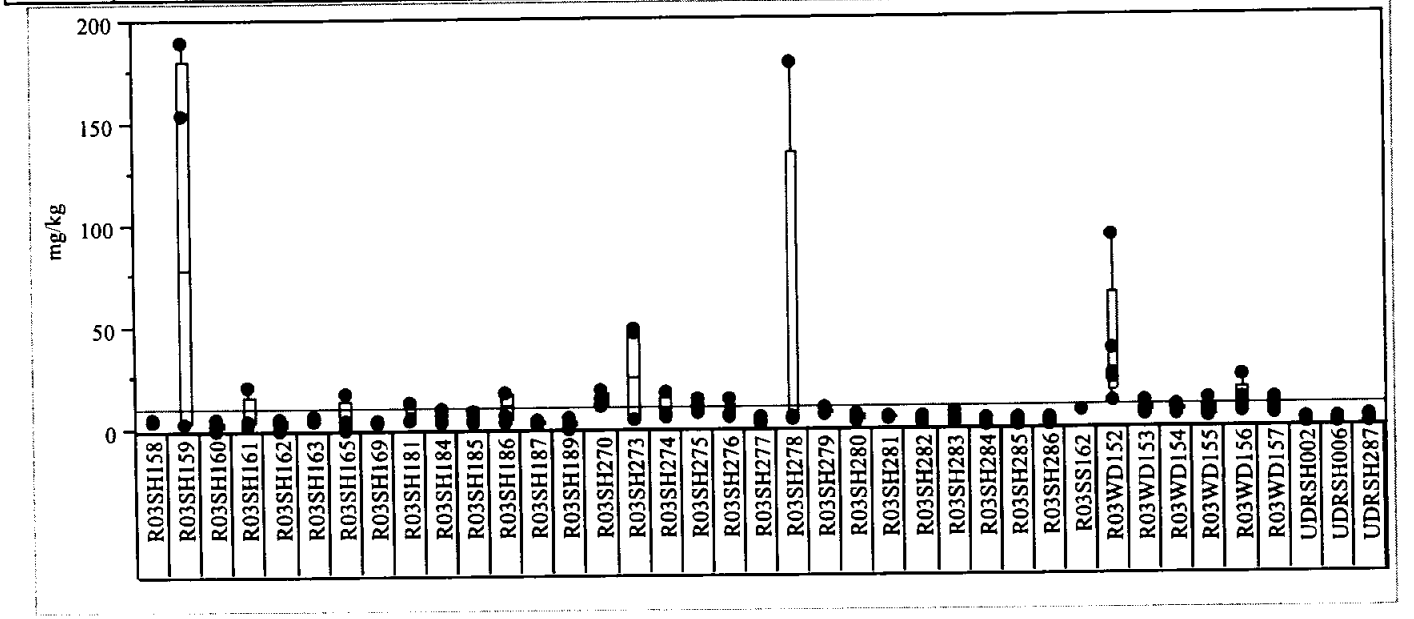
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R02SS136	174.00	167.00	171.00	214.00	196.00
R02SS137	295.00	2,670.00	1,700.00	1,210.00	765.00
R02SS139	176.00	179.00	241.00	164.00	385.00
R02SS140	180.00	172.00	218.00	239.00	146.00
R02SS141	206.00	157.00	155.00	147.00	139.00
R02SS142	724.00	200.00	183.00	179.00	173.00
R02SS144	1,700.00	415.00	574.00	1,080.00	74.90
R02SS145	316.00	171.00	203.00	494.00	144.00
R02SS146	58.50	175.00	221.00	163.00	420.00
R02SS147	328.00	210.00	224.00	205.00	157.00
R02SS148	4,140.00	4,980.00	3,540.00	3,980.00	2,330.00
R02SS149	673.00	2,090.00	10,800.00	410.00	1,300.00
R02SS150	3,880.00	343.00	359.00	206.00	375.00
R02SS151	81.00	238.00	240.00	105.00	207.00
R02SS207	159.00	63.70	51.60	31.20	338.00
R02SS267		1,840.00	1,310.00	1,080.00	375.00
R02SS268		156.00	1,200.00	807.00	192.00
R02SS269		475.00	300.00	1,110.00	326.00
R02SS271		55.00	6,750.00	3,970.00	2,680.00
R02SS272		996.00	475.00	342.00	209.00

Spatial Unit 13, ARSENIC

Oneway Analysis of mg/kg By LOCATION

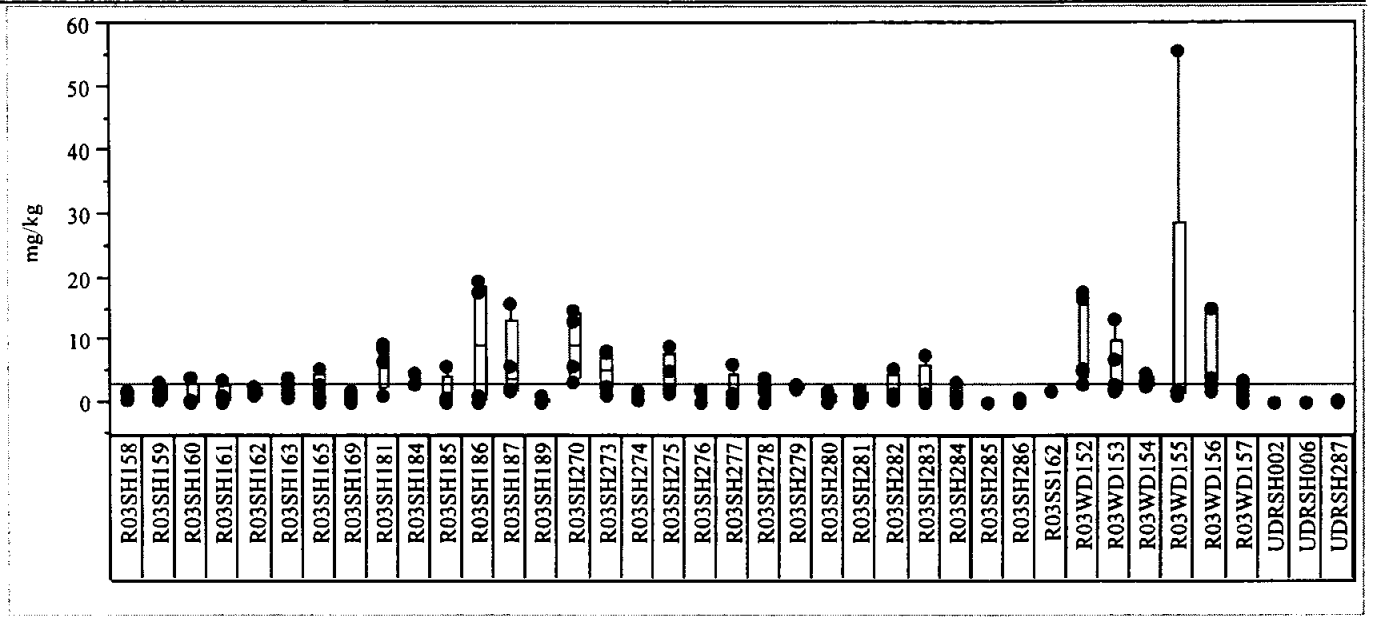


Location	Round 1	2	3	4	5
R03SH158		4.30	5.70	4.60	4.80
R03SH159		154.00	190.00	2.80	3.30
R03SH160		0.45	2.70	5.20	1.15
R03SH161		20.70	4.40	2.60	4.10
R03SH162		0.47	6.00	2.90	3.70
R03SH163		7.20	5.40	5.60	4.80
R03SH165		0.56	4.50	3.80	17.50
R03SH169		3.60	4.00	3.10	4.50
R03SH181		13.20	13.80	3.90	4.50
R03SH184		6.50	10.40	3.80	4.00
R03SH185		8.20	9.40	3.90	3.00
R03SH186		18.00	17.40	6.90	3.50
R03SH187		4.70	4.60	3.70	1.85
R03SH189	5.80	0.47	2.50	1.05	2.60
R03SH270		19.00	14.20	10.60	12.70
R03SH273		49.40	47.00	4.30	4.70
R03SH274		6.80	5.70	17.90	5.60
R03SH275		14.40	14.50	8.60	7.70
R03SH276		6.60	5.80	14.60	5.10
R03SH277		5.70	5.20	2.90	1.90

Location	Round 1	2	3	4	5
R03SH278		179.00	5.60	4.60	4.50
R03SH279		9.70	7.10	6.30	6.20
R03SH280		4.30	7.00	4.40	3.60
R03SH281		5.00	5.90	4.80	4.20
R03SH282		4.20	5.30	4.50	2.60
R03SH283		4.10	5.60	8.20	2.10
R03SH284		3.60	4.40	3.10	1.30
R03SH285		4.80	2.60	2.70	0.60
R03SH286		4.20	2.40	3.30	1.60
R03SS162	7.40				
R03WD152	22.90	93.30	26.10	37.90	12.00
R03WD153	7.80	5.70	12.70	7.80	8.30
R03WD154	7.60	7.40	8.60	10.10	5.80
R03WD155	13.80	4.10	8.90	5.80	6.40
R03WD156	10.90	24.20	13.30	7.70	7.00
R03WD157	11.40	6.70	11.80	5.10	13.10
UDRSH002	3.70	3.10	2.90	1.60	0.80
UDRSH006	3.40	3.20	3.10	1.50	2.50
UDRSH287		3.80	4.20	2.90	1.45

Spatial Unit 13, CADMIUM

Oneway Analysis of mg/kg By LOCATION

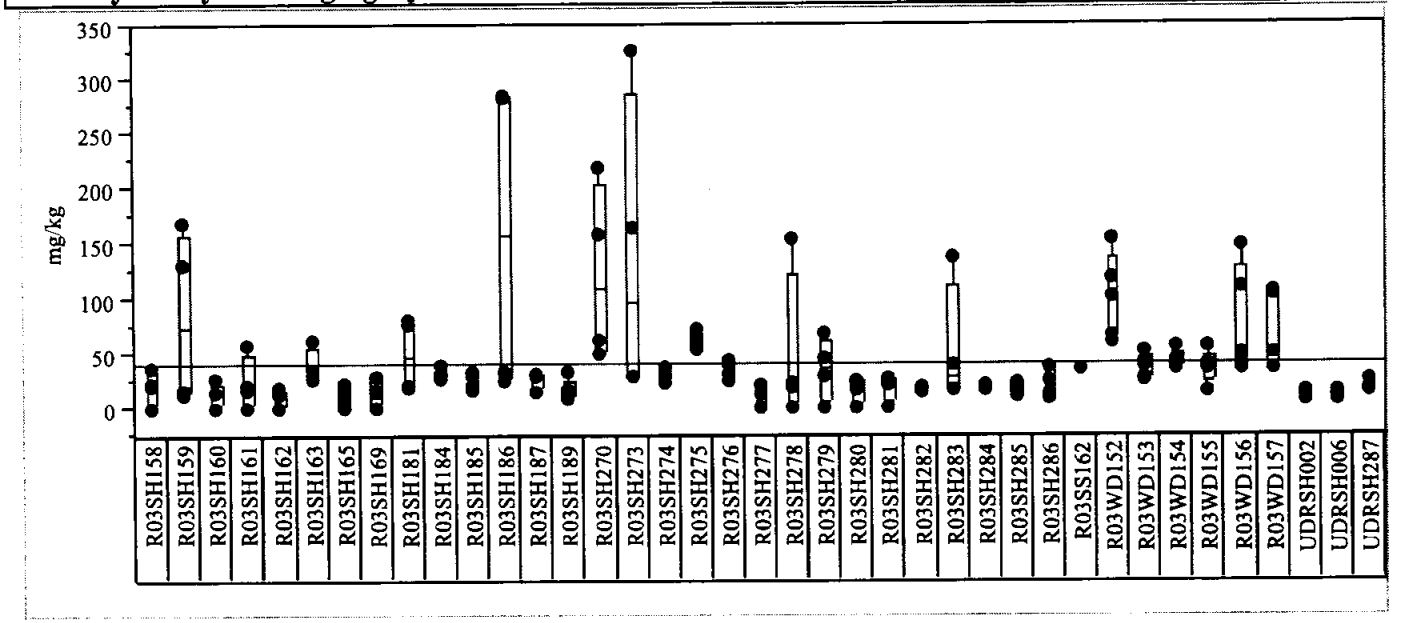


Location	Round 1	2	3	4	5
R03SH158		2.00	1.50	0.47	1.90
R03SH159		1.90	3.40	0.72	0.41
R03SH160		0.54	0.02	4.00	0.16
R03SH161		3.70	0.02	1.20	0.89
R03SH162		1.40	2.60	1.20	2.00
R03SH163		3.90	3.00	0.85	1.50
R03SH165		5.30	0.02	0.67	2.80
R03SH169		0.46	0.03	0.02	2.00
R03SH181		8.90	9.40	1.00	6.70
R03SH184		4.90	4.60	2.80	2.90
R03SH185		0.04	0.83	0.64	5.80
R03SH186		17.60	19.40	0.03	1.05
R03SH187		5.70	2.00	2.10	15.80
R03SH189	1.30	0.04	0.03	0.04	0.03
R03SH270		13.00	15.00	3.30	5.80
R03SH273		8.20	8.10	1.30	2.50
R03SH274		0.69	1.60	0.27	1.90
R03SH275		1.80	1.60	5.00	9.10
R03SH276		0.12	2.00	0.18	2.20
R03SH277		0.11	1.40	0.57	6.10

Location	Round 1	2	3	4	5
R03SH278		2.00	0.02	3.90	3.00
R03SH279		2.50	2.30	2.30	3.10
R03SH280		0.12	0.03	1.00	1.80
R03SH281		0.20	0.02	0.68	2.30
R03SH282		5.60	1.60	0.85	0.58
R03SH283		0.11	1.20	1.60	7.80
R03SH284		0.13	1.10	0.02	3.20
R03SH285		0.16	0.03	0.16	0.06
R03SH286		0.12	0.03	0.21	0.64
R03SS162	1.70				
R03WD152	2.90	16.70	5.20	17.60	5.60
R03WD153	6.90	1.70	13.40	2.10	2.80
R03WD154	3.80	4.80	3.70	2.90	2.50
R03WD155	1.70	1.30	55.70	2.00	1.90
R03WD156	1.90	15.30	15.10	3.10	3.90
R03WD157	3.20	0.14	3.70	1.10	3.00
UDRSH002	0.04	0.04	0.03	0.03	0.05
UDRSH006	0.04	0.08	0.03	0.03	0.04
UDRSH287		0.04	0.03	0.04	0.32

Spatial Unit 13, COPPER

Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R03SH158		20.40	0.08	23.70	38.40
R03SH159		132.00	168.00	12.80	16.50
R03SH160		15.30	0.08	26.70	14.10
R03SH161		58.50	0.08	15.70	20.90
R03SH162		16.40	0.08	11.90	18.00
R03SH163		63.00	26.40	35.60	31.90
R03SH165		22.00	0.09	9.90	15.20
R03SH169		15.00	0.10	16.20	29.90
R03SH181		77.90	81.30	20.00	18.00
R03SH184		32.10	39.20	27.70	29.90
R03SH185		30.20	32.30	21.70	15.90
R03SH186		285.00	283.00	34.00	25.80
R03SH187		30.00	15.20	31.60	28.50
R03SH189	32.70	8.60	12.80	13.20	17.30
R03SH270		218.00	159.00	49.80	62.40
R03SH273		165.00	327.00	29.20	29.10
R03SH274		29.30	23.60	37.50	36.70
R03SH275		73.80	57.50	67.20	53.70
R03SH276		43.50	24.10	31.80	40.30
R03SH277		11.80	0.09	20.50	20.30

Location	Round 1	2	3	4	5
R03SH278		155.00	0.08	19.20	23.50
R03SH279		46.00	0.08	68.60	28.50
R03SH280		16.70	0.11	24.20	23.60
R03SH281		20.80	0.08	27.10	23.00
R03SH282		14.10	15.30	17.30	19.60
R03SH283		17.30	17.50	137.00	38.80
R03SH284		19.30	17.70	18.60	20.40
R03SH285		22.60	15.00	18.10	10.50
R03SH286		11.90	8.70	38.00	24.20
R03SS162	35.00				
R03WD152	61.10	155.00	118.00	102.00	66.10
R03WD153	28.10	24.30	52.70	41.80	37.00
R03WD154	34.50	43.40	43.50	55.50	40.20
R03WD155	56.40	14.50	35.20	38.60	37.50
R03WD156	49.00	148.00	110.00	39.80	36.00
R03WD157	50.40	34.60	106.00	50.80	104.00
UDRSH002	14.30	10.90	11.80	6.30	10.30
UDRSH006	5.90	13.00	11.40	6.10	14.00
UDRSH287		17.00	17.10	14.90	25.40

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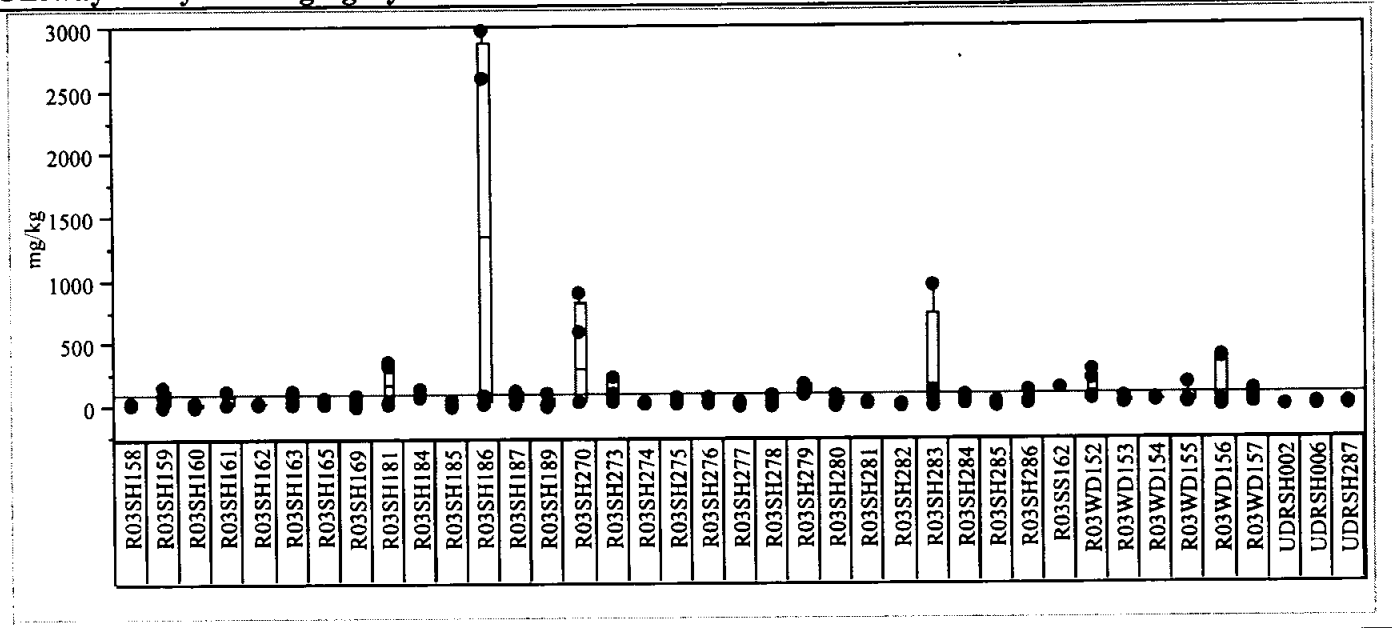
Spatial Unit 13, LEAD

Oneway Analysis of mg/kg By LOCATION

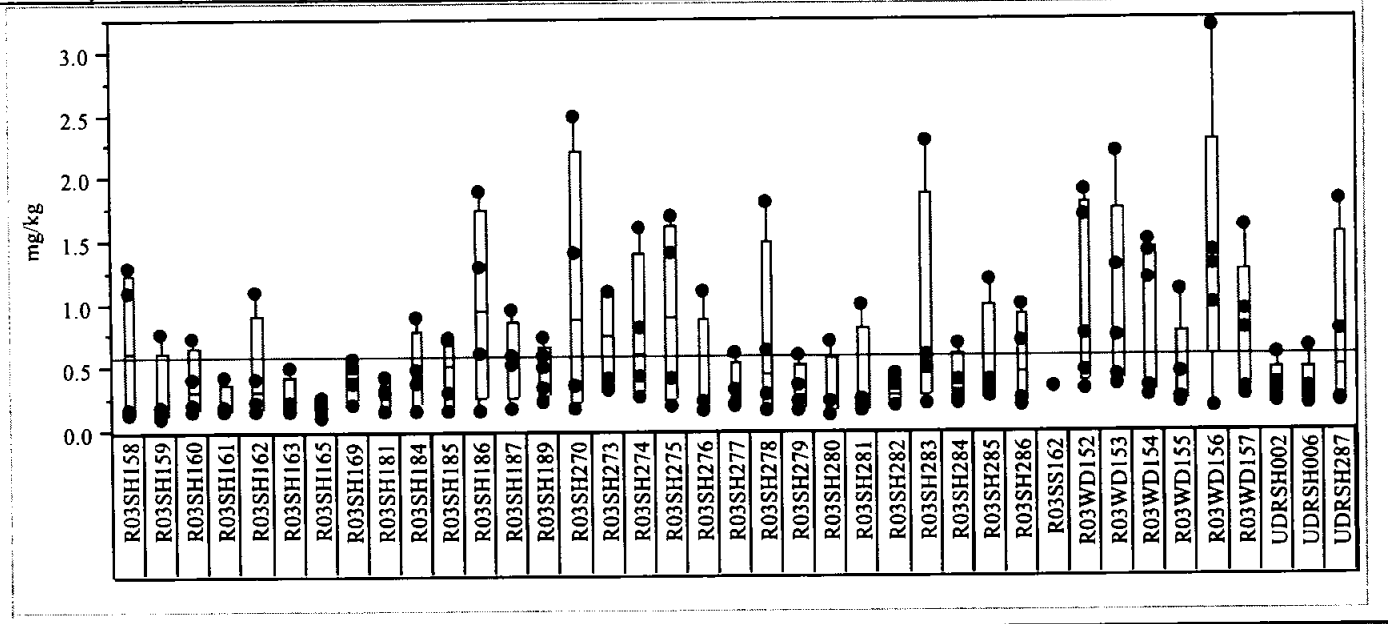


Location	Round 1	2	3	4	5
R03SH158		37.30	41.70	25.10	41.10
R03SH159		102.00	168.00	29.10	10.00
R03SH160		7.00	12.20	45.30	8.30
R03SH161		124.00	23.80	19.70	13.10
R03SH162		33.20	37.40	25.20	34.00
R03SH163		136.00	32.50	32.00	29.20
R03SH165		68.90	16.70	18.60	23.40
R03SH169		5.60	6.10	8.60	90.80
R03SH181		322.00	367.00	42.10	17.00
R03SH184		87.10	79.70	91.00	156.00
R03SH185		8.80	14.70	57.40	6.90
R03SH186		2,610.00	2,990.00	14.40	93.20
R03SH187		129.00	23.80	104.00	70.10
R03SH189	120.00	12.20	14.60	9.70	11.50
R03SH270		907.00	591.00	38.70	40.70
R03SH273		112.00	245.00	33.30	42.30
R03SH274		30.20	23.50	36.30	33.70
R03SH275		61.20	78.30	27.00	32.10
R03SH276		66.50	27.80	26.30	45.60
R03SH277		40.90	10.30	17.30	30.50

Location	Round 1	2	3	4	5
R03SH278		93.60	11.00	44.80	46.30
R03SH279		138.00	128.00	88.30	188.00
R03SH280		7.40	88.60	39.10	41.60
R03SH281		26.00	46.80	43.00	41.60
R03SH282		9.30	17.10	27.60	10.00
R03SH283		6.90	26.50	951.00	135.00
R03SH284		30.70	64.10	15.80	92.00
R03SH285		39.90	19.40	39.10	10.30
R03SH286		17.50	19.80	125.00	40.90
R03SS162	148.00				
R03WD152	59.00	285.00	223.00	77.60	53.70
R03WD153	17.50	18.40	75.40	36.00	18.80
R03WD154	38.00	65.40	57.80	59.20	38.90
R03WD155	25.60	12.40	184.00	33.90	37.80
R03WD156	0.23	408.00	376.00	28.40	31.00
R03WD157	22.80	15.30	63.10	38.50	126.00
UDRSH002	9.00	7.20	7.80	4.50	6.80
UDRSH006	4.50	12.30	8.70	3.60	7.50
UDRSH287		10.60	18.50	9.80	17.30

Spatial Unit 13, SELENIUM

Oneway Analysis of mg/kg By LOCATION

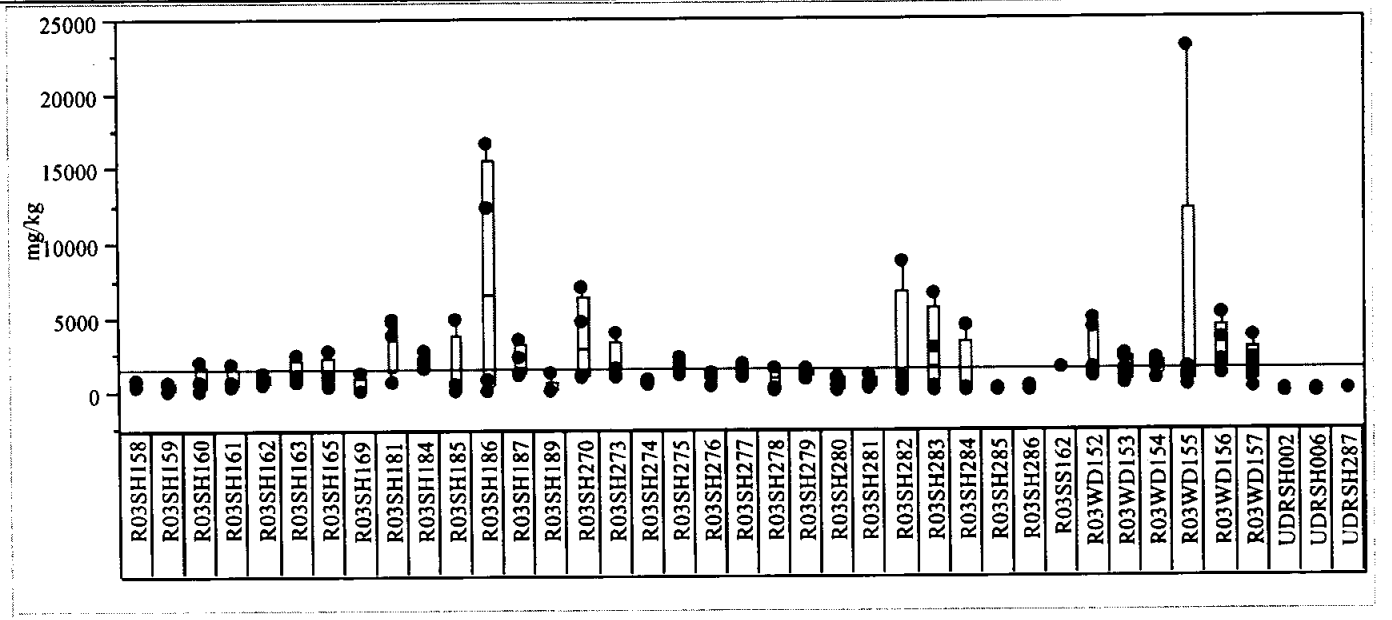


Location	Round 1	2	3	4	5
R03SH158		1.10	0.18	1.30	0.15
R03SH159		0.20	0.16	0.77	0.12
R03SH160		0.23	0.16	0.74	0.42
R03SH161		0.19	0.17	0.44	0.16
R03SH162		0.23	0.17	0.41	1.10
R03SH163		0.22	0.16	0.50	0.24
R03SH165		0.28	0.19	0.11	0.12
R03SH169		0.50	0.22	0.58	0.38
R03SH181		0.30	0.16	0.32	0.44
R03SH184		0.49	0.16	0.38	0.90
R03SH185		0.74	0.16	0.32	0.73
R03SH186		1.90	0.16	1.30	0.62
R03SH187		0.52	0.19	0.95	0.60
R03SH189	0.60	0.24	0.74	0.51	0.35
R03SH270		0.36	0.19	1.40	2.50
R03SH273		0.33	0.41	1.10	1.10
R03SH274		0.28	0.81	1.60	0.44
R03SH275		0.42	0.19	1.40	1.70
R03SH276		0.23	0.17	1.10	0.16
R03SH277		0.22	0.19	0.32	0.62

Location	Round 1	2	3	4	5
R03SH278		1.80	0.16	0.63	0.29
R03SH279		0.24	0.17	0.59	0.36
R03SH280		0.24	0.23	0.70	0.14
R03SH281		0.26	0.16	1.00	0.21
R03SH282		0.20	0.21	0.45	0.37
R03SH283		0.21	0.59	0.49	2.30
R03SH284		0.26	0.21	0.69	0.40
R03SH285		0.31	0.27	1.20	0.41
R03SH286		0.25	0.20	0.99	0.70
R03SS162	0.35				
R03WD152	0.75	0.32	0.48	1.70	1.90
R03WD153	0.74	0.37	0.43	2.20	1.30
R03WD154	1.50	0.34	0.28	1.40	1.20
R03WD155	0.45	0.21	0.26	1.10	0.25
R03WD156	1.00	3.20	0.18	1.30	1.40
R03WD157	0.80	0.27	0.33	0.94	1.60
UDRSH002	0.60	0.24	0.22	0.36	0.30
UDRSH006	0.65	0.21	0.24	0.33	0.30
UDRSH287		0.24	0.22	0.78	1.80

Spatial Unit 13, ZINC

Oneway Analysis of mg/kg By LOCATION

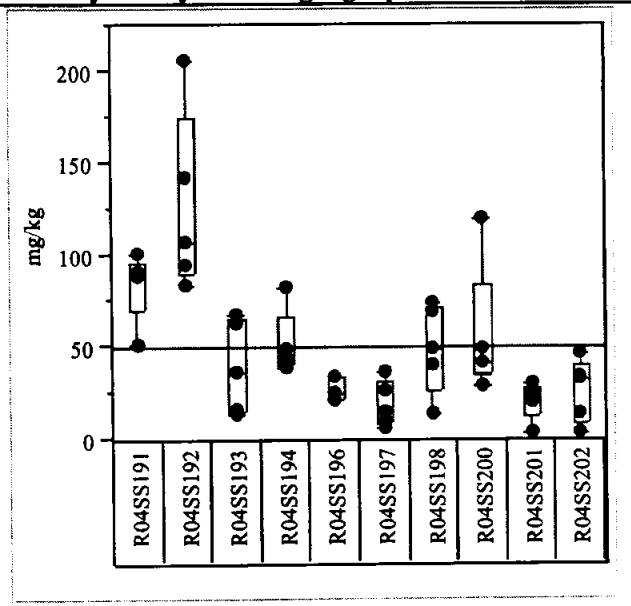


Location	Round 1	2	3	4	5
R03SH158		922.00	900.00	432.00	873.00
R03SH159		480.00	739.00	532.00	31.50
R03SH160		638.00	673.00	2,090.00	91.70
R03SH161		2,000.00	431.00	710.00	412.00
R03SH162		497.00	1,310.00	928.00	787.00
R03SH163		2,590.00	1,200.00	706.00	1,050.00
R03SH165		2,780.00	355.00	475.00	1,040.00
R03SH169		62.30	89.80	89.40	1,270.00
R03SH181		4,800.00	3,900.00	720.00	4,920.00
R03SH184		2,180.00	2,870.00	1,960.00	1,610.00
R03SH185		119.00	542.00	554.00	4,990.00
R03SH186		16,800.00	12,500.00	165.00	910.00
R03SH187		2,330.00	1,310.00	1,110.00	3,680.00
R03SH189	1,250.00	61.90	63.30	40.60	51.30
R03SH270		7,120.00	4,770.00	1,040.00	1,190.00
R03SH273		1,610.00	4,030.00	985.00	1,060.00
R03SH274		532.00	703.00	645.00	873.00
R03SH275		1,120.00	1,210.00	1,550.00	2,370.00
R03SH276		1,310.00	1,260.00	444.00	1,070.00
R03SH277		1,340.00	982.00	1,810.00	1,950.00

Location	Round 1	2	3	4	5
R03SH278		279.00	42.90	1,670.00	1,670.00
R03SH279		1,220.00	933.00	1,650.00	1,280.00
R03SH280		102.00	378.00	935.00	1,060.00
R03SH281		187.00	299.00	585.00	1,240.00
R03SH282		8,870.00	949.00	564.00	161.00
R03SH283		70.20	474.00	6,620.00	3,040.00
R03SH284		190.00	250.00	82.40	4,530.00
R03SH285		173.00	79.10	180.00	48.00
R03SH286		65.80	69.40	460.00	158.00
R03SS162	1,550.00				
R03WD152	1,070.00	5,060.00	1,660.00	4,420.00	1,260.00
R03WD153	2,490.00	527.00	2,270.00	949.00	1,450.00
R03WD154	2,190.00	1,850.00	1,590.00	1,680.00	877.00
R03WD155	448.00	828.00	23,100.00	1,690.00	1,110.00
R03WD156	1,840.00	5,360.00	3,630.00	1,170.00	2,010.00
R03WD157	1,620.00	241.00	2,310.00	1,080.00	3,690.00
UDRSH002	62.40	29.10	34.00	15.70	29.00
UDRSH006	29.30	45.80	36.40	20.30	38.80
UDRSH287		48.40	77.00	41.30	76.60

Spatial Unit 14, ARSENIC

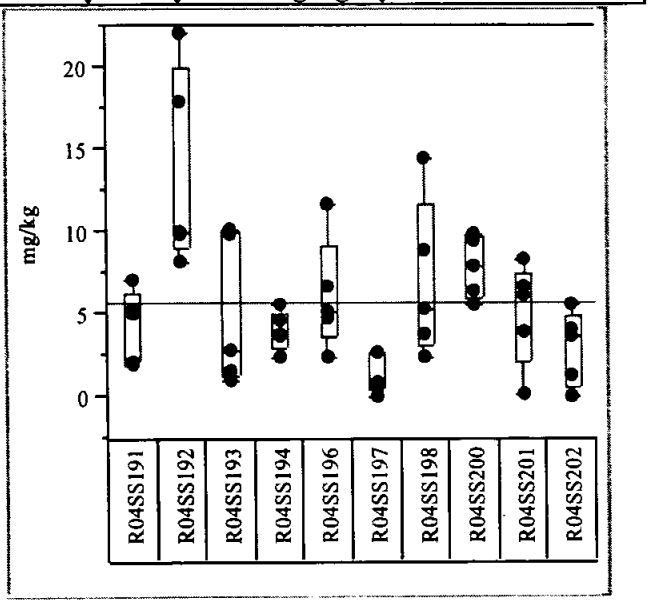
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04SS191	90.80	90.70	101.00	51.60	88.20
R04SS192	94.60	206.00	108.00	84.30	143.00
R04SS193	13.60	36.10	67.30	63.10	16.00
R04SS194	48.30	83.10	43.30	41.90	38.20
R04SS196	33.90	33.40	25.40	21.00	21.70
R04SS197	10.20	15.40	26.00	35.70	6.80
R04SS198	49.20	39.40	69.30	13.60	73.20
R04SS200	41.00	48.40	120.00	28.40	41.80
R04SS201	19.90	30.60	23.60	4.00	24.10
R04SS202	3.50	13.40	34.00	46.30	31.90

Spatial Unit 14, CADMIUM

Oneway Analysis of mg/kg By LOCATION

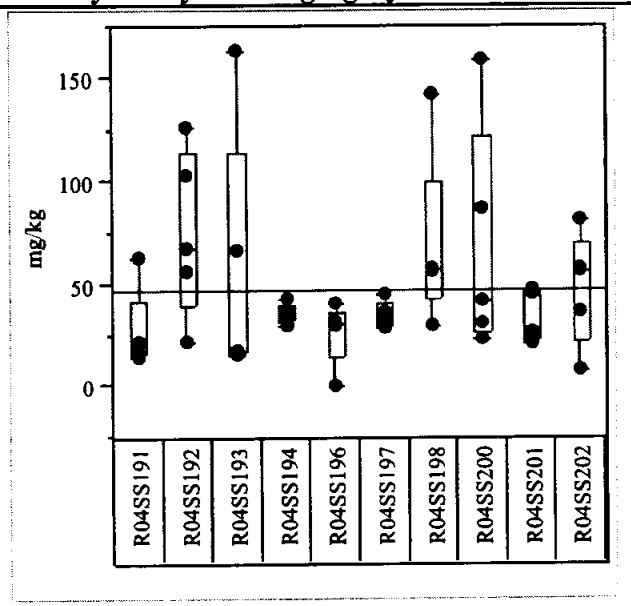


Location	Round 1	2	3	4	5
R04SS191	2.00	7.10	5.00	2.10	5.30
R04SS192	8.20	22.10	9.80	10.00	17.90
R04SS193	2.80	1.50	10.20	9.80	0.92
R04SS194	3.70	5.50	3.60	4.60	2.30
R04SS196	11.70	6.70	4.70	2.40	5.20
R04SS197	0.02	0.81	2.60	2.70	0.72
R04SS198	5.30	8.90	14.40	2.40	3.80
R04SS200	9.50	6.40	7.90	5.50	9.90
R04SS201	3.90	8.40	6.60	0.13	6.10
R04SS202	0.03	1.20	5.60	3.60	4.00

DS.0373.15382

Spatial Unit 14, COPPER

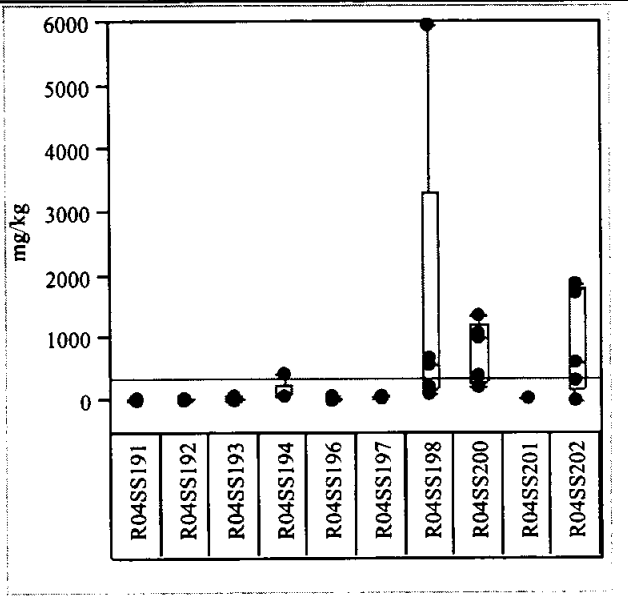
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04SS191	14.60	63.90	22.70	22.10	17.00
R04SS192	23.30	127.00	68.00	57.20	104.00
R04SS193	16.10	18.10	66.80	164.00	18.50
R04SS194	34.50	38.50	36.40	43.40	30.50
R04SS196	30.50	41.50	0.08	32.50	31.50
R04SS197	29.60	34.00	36.70	46.50	29.10
R04SS198	58.30	58.20	143.00	31.10	57.70
R04SS200	86.90	43.00	31.50	23.80	159.00
R04SS201	23.60	45.60	48.50	21.40	27.20
R04SS202	8.70	37.30	82.10	57.20	58.40

Spatial Unit 14, LEAD

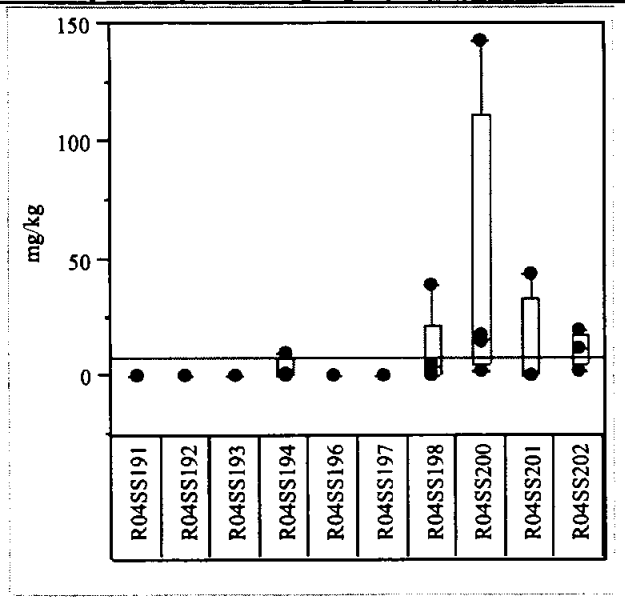
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04SS191	7.00	29.10	11.20	10.60	6.80
R04SS192	9.20	37.90	14.60	45.30	18.00
R04SS193	12.90	13.30	62.00	24.40	11.00
R04SS194	72.70	88.50	70.80	450.00	71.80
R04SS196	22.90	20.80	72.50	30.00	19.40
R04SS197	70.20	44.70	47.00	65.00	43.00
R04SS198	213.00	707.00	5,980.00	126.00	577.00
R04SS200	400.00	1,030.00	1,360.00	213.00	1,100.00
R04SS201	43.60	48.30	37.30	32.80	26.50
R04SS202	6.70	333.00	1,740.00	631.00	1,880.00

Spatial Unit 14, MERCURY

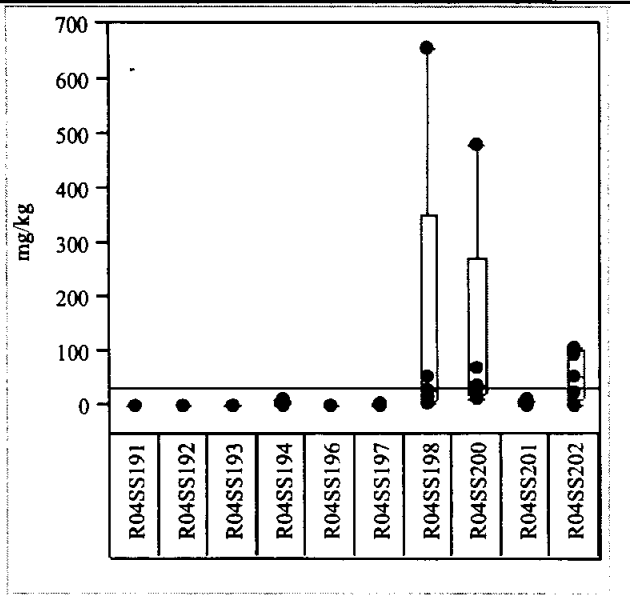
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04SS191		0.03	0.06	0.03	0.03
R04SS192		0.03	0.03	0.25	0.03
R04SS193		0.02	0.03	0.15	0.03
R04SS194		1.50	0.37	10.00	0.33
R04SS196		0.03	0.06	0.18	0.06
R04SS197		0.03	0.03	0.67	0.27
R04SS198	4.90	38.80	3.70	1.20	0.10
R04SS200		14.50	18.00	2.30	143.00
R04SS201		44.40	0.03	0.02	0.39
R04SS202		2.30	12.40	12.40	19.90

Spatial Unit 14, SELENIUM

Oneway Analysis of mg/kg By LOCATION

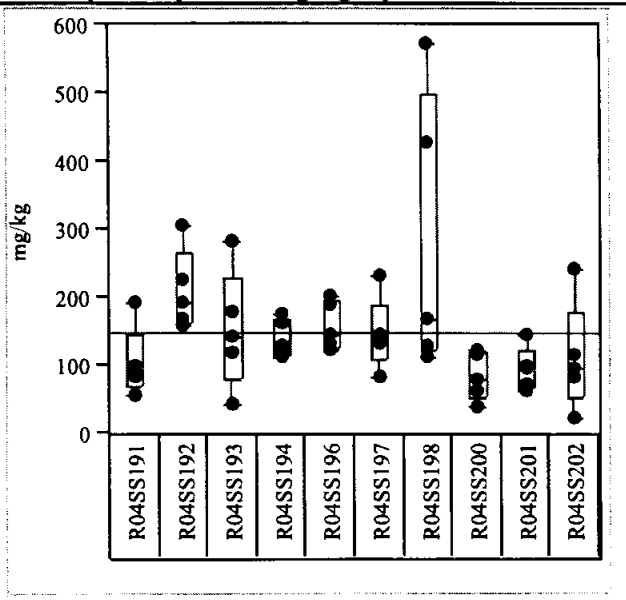


Location	Round 1	2	3	4	5
R04SS191	0.36	0.24	0.16	1.10	0.34
R04SS192	0.37	0.20	0.16	1.80	0.42
R04SS193	0.36	0.19	0.16	1.90	0.25
R04SS194	0.37	6.60	5.10	13.80	0.70
R04SS196	0.37	0.22	0.17	1.70	0.36
R04SS197	0.36	0.19	0.16	3.30	0.25
R04SS198	16.40	55.10	657.00	4.40	29.70
R04SS200	36.00	71.70	482.00	12.80	30.20
R04SS201	12.70	6.00	7.50	0.81	6.60
R04SS202	0.39	23.30	97.90	53.60	109.00

DS.0373.15382

Spatial Unit 14, ZINC

Oneway Analysis of mg/kg By LOCATION

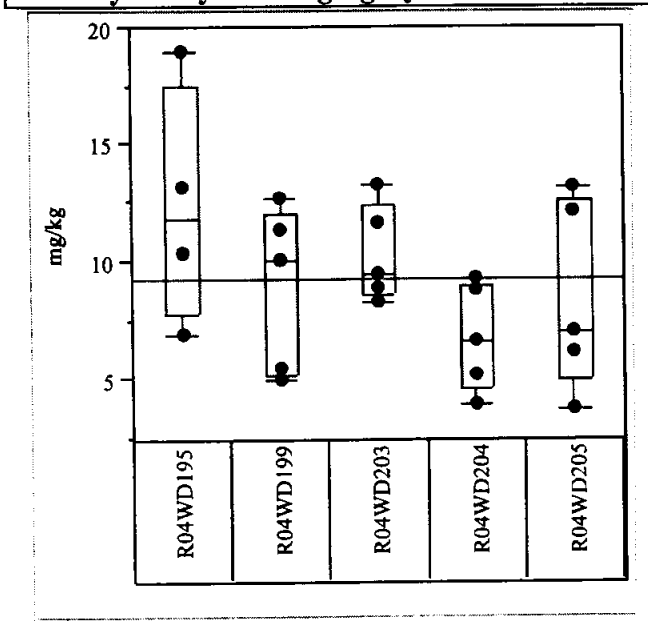


Location	Round 1	2	3	4	5
R04SS191	89.50	193.00	98.70	56.00	84.00
R04SS192	195.00	308.00	169.00	159.00	227.00
R04SS193	119.00	145.00	282.00	180.00	43.80
R04SS194	117.00	162.00	176.00	129.00	112.00
R04SS196	190.00	146.00	205.00	122.00	134.00
R04SS197	232.00	145.00	146.00	134.00	85.00
R04SS198	114.00	431.00	572.00	171.00	130.00
R04SS200	125.00	81.50	63.80	40.80	118.00
R04SS201	64.10	146.00	95.90	72.20	99.00
R04SS202	21.90	116.00	242.00	84.80	97.20

DS.0373.15382

Spatial Unit 15, ARSENIC

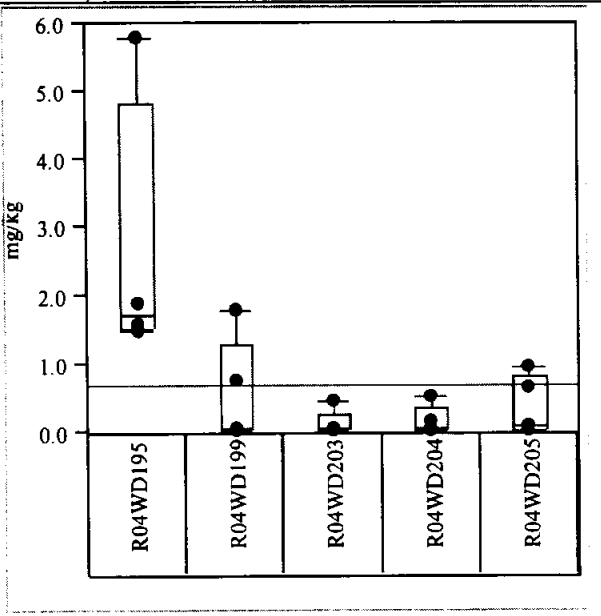
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		19.00	13.20	10.40	7.00
R04WD199	10.10	12.70	5.50	5.00	11.30
R04WD203	11.60	13.30	9.50	8.30	8.90
R04WD204	6.70	8.80	9.30	4.00	5.20
R04WD205	3.80	12.10	13.20	6.20	7.10

Spatial Unit 15, CADMIUM

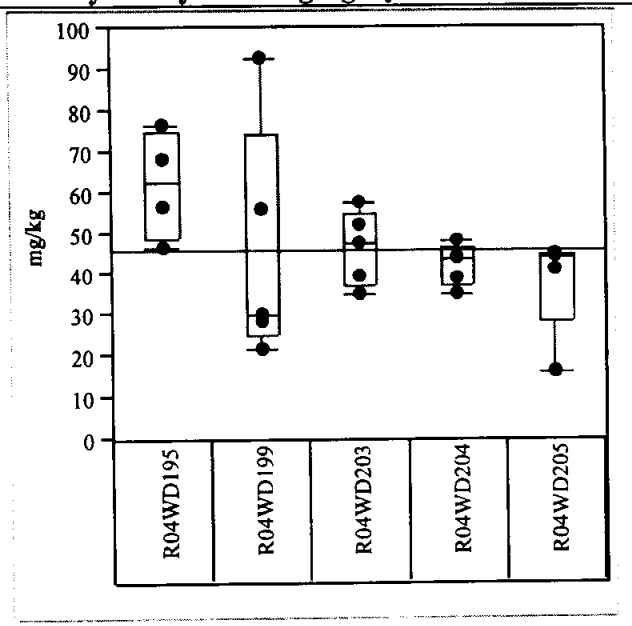
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		5.80	1.50	1.90	1.60
R04WD199	0.06	0.78	0.04	0.07	1.80
R04WD203	0.04	0.08	0.03	0.07	0.46
R04WD204	0.04	0.16	0.05	0.08	0.55
R04WD205	0.02	0.98	0.03	0.09	0.68

Spatial Unit 15, COPPER

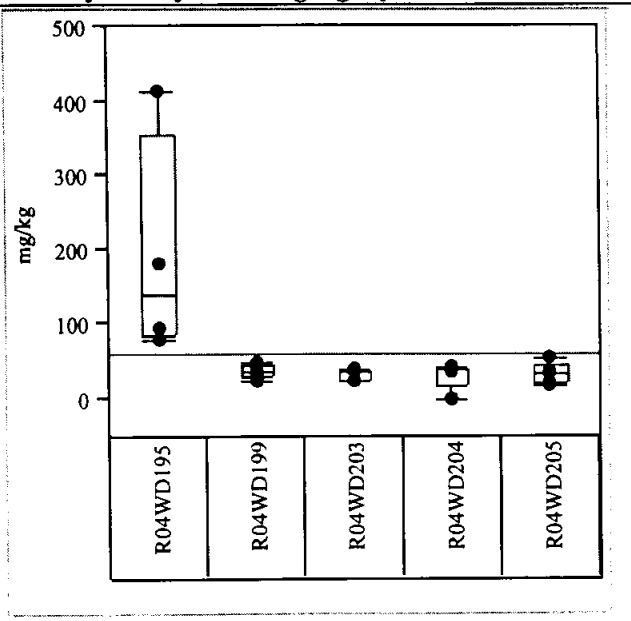
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		76.90	56.80	68.60	46.40
R04WD199	93.00	28.40	21.80	30.00	56.30
R04WD203	39.30	57.70	34.80	47.60	52.40
R04WD204	48.20	44.60	44.10	35.00	39.10
R04WD205	16.00	44.30	44.80	45.20	41.10

Spatial Unit 15, LEAD

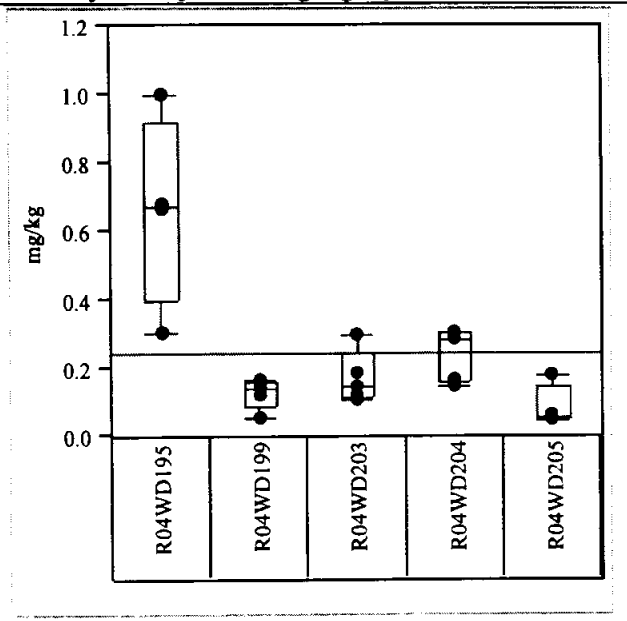
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		93.00	413.00	183.00	79.70
R04WD199	39.20	33.90	23.60	36.30	48.00
R04WD203	35.50	38.60	23.60	35.10	22.30
R04WD204	0.32	36.40	41.10	37.10	37.10
R04WD205	20.90	17.60	33.30	53.50	34.90

Spatial Unit 15, MERCURY

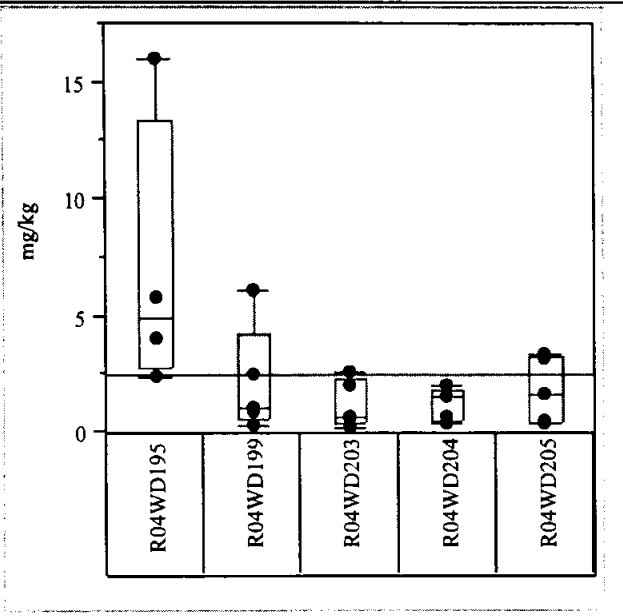
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		0.68	1.00	0.67	0.31
R04WD199	0.17	0.12	0.15	0.14	0.06
R04WD203	0.11	0.19	0.12	0.15	0.30
R04WD204	0.29	0.15	0.30	0.17	0.31
R04WD205		0.05	0.05	0.18	0.06

Spatial Unit 15, SELENIUM

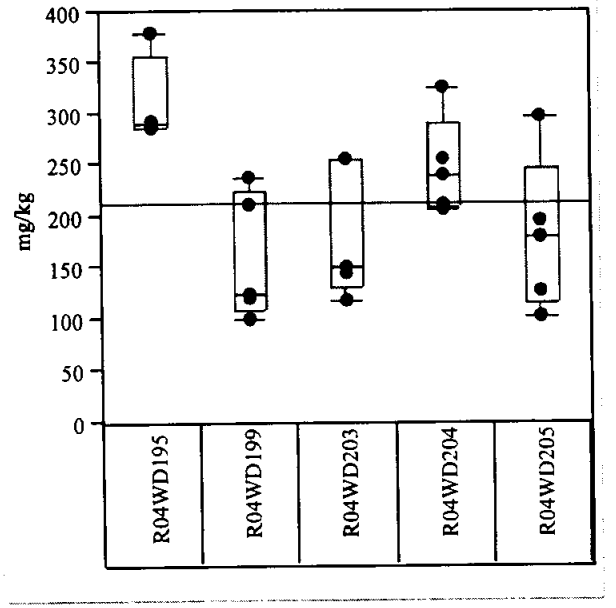
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		4.10	16.00	5.80	2.40
R04WD199	0.90	1.10	0.32	2.50	6.10
R04WD203	0.65	2.00	0.24	2.60	0.55
R04WD204	1.60	1.60	0.41	2.00	0.65
R04WD205	0.37	1.70	3.20	3.40	0.48

Spatial Unit 15, ZINC

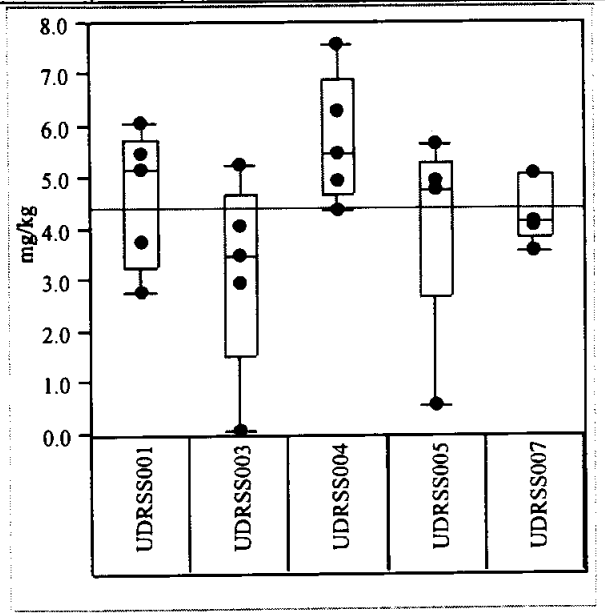
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
R04WD195		289.00	287.00	380.00	293.00
R04WD199	211.00	120.00	100.00	124.00	237.00
R04WD203	151.00	255.00	118.00	255.00	144.00
R04WD204	255.00	241.00	327.00	212.00	206.00
R04WD205	103.00	127.00	179.00	298.00	196.00

Spatial Unit 16, ARSENIC

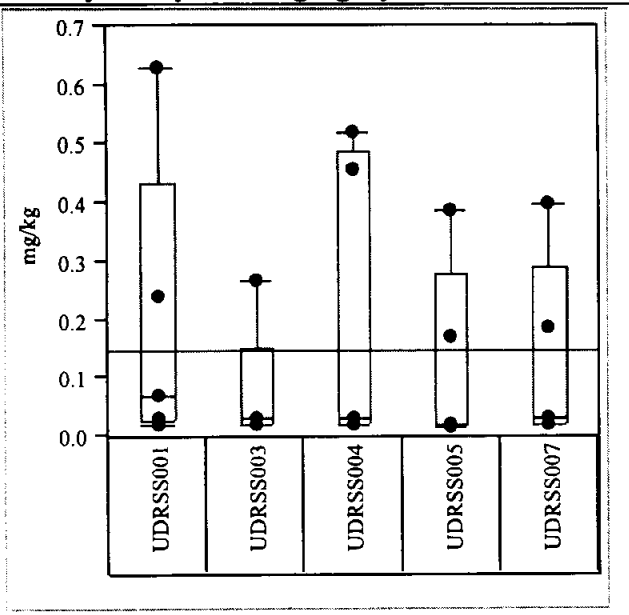
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
UDRSS001	5.20	6.10	5.50	2.80	3.80
UDRSS003	5.30	4.10	0.10	3.50	3.00
UDRSS004	5.00	5.50	7.60	6.30	4.40
UDRSS005	5.00	5.70	4.80	0.60	4.80
UDRSS007	5.10	4.20	5.10	3.60	4.10

Spatial Unit 16, CADMIUM

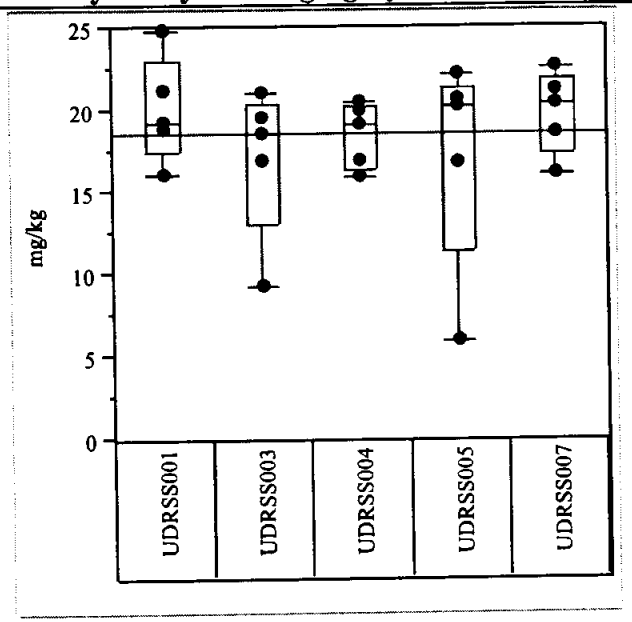
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
UDRSS001	0.02	0.07	0.03	0.24	0.63
UDRSS003	0.02	0.03	0.02	0.27	0.03
UDRSS004	0.02	0.03	0.02	0.46	0.52
UDRSS005	0.02	0.17	0.02	0.02	0.39
UDRSS007	0.02	0.03	0.02	0.40	0.19

Spatial Unit 16, COPPER

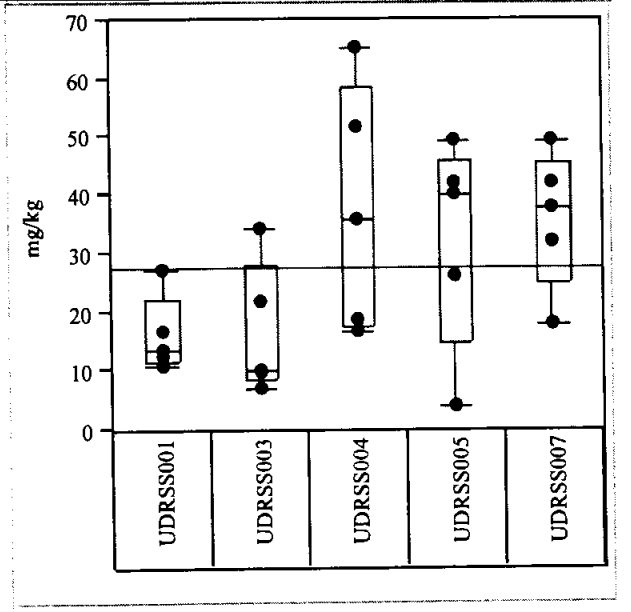
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
UDRSS001	16.10	21.30	19.30	18.90	24.90
UDRSS003	18.60	16.90	9.30	19.60	21.10
UDRSS004	16.90	16.00	20.60	20.00	19.20
UDRSS005	16.80	20.30	20.70	6.00	22.20
UDRSS007	18.60	16.10	20.40	22.60	21.30

Spatial Unit 16, LEAD

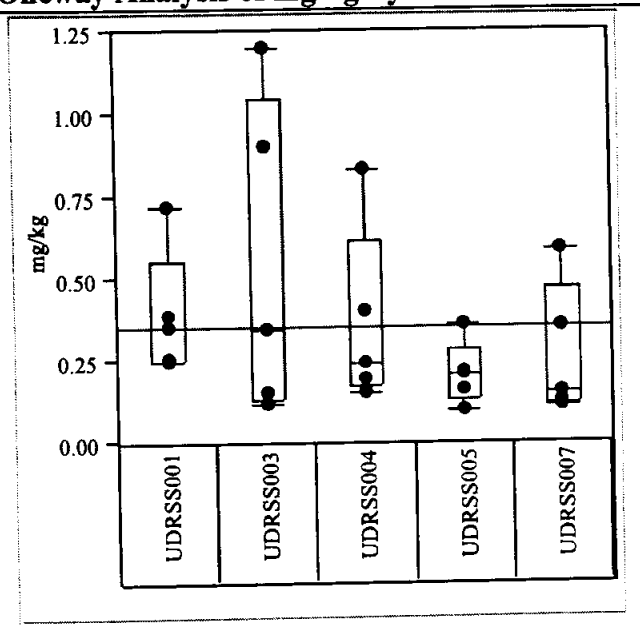
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
UDRSS001	13.50	27.40	16.90	10.90	12.50
UDRSS003	34.10	10.00	6.90	9.90	21.60
UDRSS004	18.50	16.80	65.50	35.90	51.60
UDRSS005	26.00	40.20	49.50	3.80	42.00
UDRSS007	31.90	17.90	37.70	42.00	49.30

Spatial Unit 16, SELENIUM

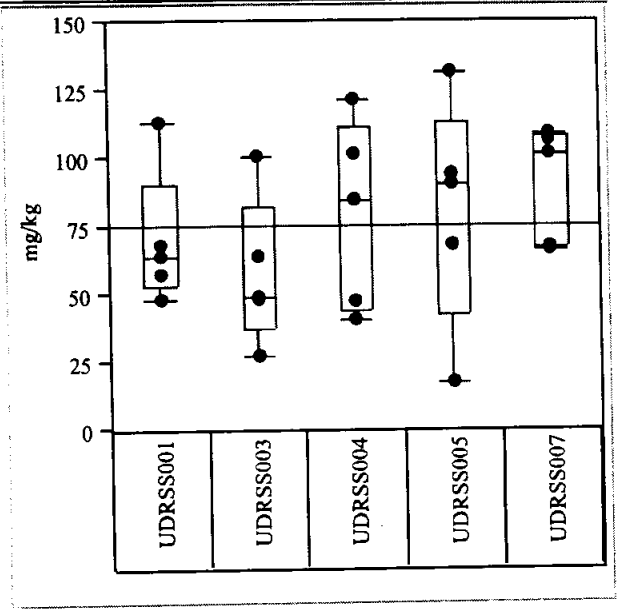
Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
UDRSS001	0.36	0.72	0.26	0.39	0.25
UDRSS003	0.35	1.20	0.16	0.12	0.90
UDRSS004	0.41	0.83	0.16	0.24	0.20
UDRSS005	0.36	0.21	0.16	0.10	0.22
UDRSS007	0.36	0.59	0.16	0.11	0.13

Spatial Unit 16, ZINC

Oneway Analysis of mg/kg By LOCATION



Location	Round 1	2	3	4	5
UDRSS001	57.70	113.00	68.50	48.40	63.80
UDRSS003	101.00	48.00	27.50	49.00	64.10
UDRSS004	47.30	41.00	122.00	84.60	102.00
UDRSS005	68.30	90.80	132.00	17.40	94.40
UDRSS007	66.40	67.90	107.00	109.00	102.00

ATTACHMENT D2

SURFACE WATER RESULTS PRE- AND POSTREMEDIATION MONITORING

(24 Pages)

ATTACHMENT D2

SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 3 Ditches																										
3	R01DH018	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	5.30	*	3.20		1.00	*	10.30	*	NS		NS		NS		NS		NS		NS	
		Year 3	1.00	*	0.19	*	5.90	*	1.40	*	1.50	*	27.70		NS		NS		NS		NS		NS		NS	
		Year 4	1.20	*	0.15	*	1.90	*	20.10		1.10	*	4.20	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
3	R01DH019	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	1.30	*	0.50	*	1.00	*	9.30	*	NS		NS		NS		NS		NS		NS	
		Year 3	1.30	*	0.10	*	6.30	*	0.70	*	0.80	*	18.00	*	NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	2.20	*	1.40	*	1.10	*	6.90	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
3	R01DH020	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	5.00	*	1.80		1.00	*	42.70		NS		NS		NS		NS		NS		NS	
		Year 3	2.00	*	0.19	*	10.10	*	2.00	*	1.50	*	25.40		NS		NS		NS		NS		NS		NS	
		Year 4	5.90		0.15	*	8.80	*	3.30	*	1.10	*	62.30		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
3	R01DH021	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	6.60	*	3.00		1.00	*	28.20		NS		NS		NS		NS		NS		NS	
		Year 3	10.00	*	0.19	*	6.40	*	1.60	*	1.50	*	29.90		NS		NS		NS		NS		NS		NS	
		Year 4	38.60		0.15	*	42.20		67.70		1.10	*	130.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
3	R01DH026	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	11.90	*	2.30		1.00	*	39.80		NS		NS		NS		NS		NS		NS	
		Year 3	2.80	*	0.19	*	60.20		3.40	*	1.50	*	77.70		NS		NS		NS		NS		NS		NS	
		Year 4	2.00	*	0.15	*	2.70	*	1.30	*	1.10	*	38.30		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
3	R01DH027	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	5.40	*	2.20		1.00	*	37.20		NS		NS		NS		NS		NS		NS	
		Year 3	2.20	*	0.19	*	10.80	*	2.40	*	1.50	*	65.90		NS		NS		NS		NS		NS		NS	
		Year 4	4.30		0.15	*	4.70	*	1.00	*	1.10	*	18.70		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 3 Ditches (continued)																										
3	R01DH035	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	9.40	*	2.10		1.00	*	31.20		NS		NS		NS		NS		NS		NS	
		Year 3	205.00		14.80		838.00		336.00		3.80	*	4,240.00		NS		NS		NS		NS		NS		NS	
		Year 4	5.70		0.15	*	3.20	*	1.30	*	1.10	*	20.60		NS		NS		NS		NS		NS		NS	
		Year 5	1.70	*	0.15	*	2.10	*	NS		1.30	*	19.60		NS		NS		NS		NS		NS		NS	
3	R01DH040	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	9.30	*	2.10		1.00	*	47.80		NS		NS		NS		NS		NS		NS	
		Year 3	20.60		0.19	*	35.70		3.50	*	1.50	*	84.90		NS		NS		NS		NS		NS		NS	
		Year 4	1.90	*	0.50	*	2.20	*	0.70	*	1.10	*	17.00	*	NS		NS		NS		NS		NS		NS	
		Year 5	41.00		4.00		105.00		NS		3.40	*	705.00		NS		NS		NS		NS		NS		NS	
3	R01DH052	Prerem.	157.00		15.80		299.00		94.70		20.50		5,000.00		12.70		1.00	*	3.00		7.70		10.00	*	12.60	
		Year 1	55.30		2.10		145.00		45.00		1.70	*	1,470.00		NS		NS		NS		NS		NS		NS	
		Year 2	12.90		0.15	*	7.20	*	3.90		1.00	*	122.00		NS		NS		NS		NS		NS		NS	
		Year 3	17.00		0.70	*	42.90		13.30		0.80	*	430.00		NS		NS		NS		NS		NS		NS	
		Year 4	142.00		11.70		384.00		105.00		1.10	*	3,490.00		NS		NS		NS		NS		NS		NS	
		Year 5	1.40	*	0.15	*	2.40	*	0.90	*	1.30	*	52.80		NS		NS		NS		NS		NS		NS	
3	R01DH061	Prerem.	5.90		1.00	*	8.80		5.70		10.00	*	70.70		4.90		1.00	*	3.90		5.00		10.00	*	49.20	
		Year 1	4.00		0.10	*	4.60	*	0.80	*	1.70	*	39.60	*	NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	3.30	*	1.40		1.00	*	14.70	*	NS		NS		NS		NS		NS		NS	
		Year 3	12.40		0.30	*	31.80		9.40		0.80	*	170.00		NS		NS		NS		NS		NS		NS	
		Year 4	4.50		0.15	*	5.10	*	0.90	*	1.10	*	19.00		NS		NS		NS		NS		NS		NS	
		Year 5	40.00		0.38	*	7.90	*	2.80	*	1.30	*	103.00		NS		NS		NS		NS		NS		NS	
3	**Prerem. Average**		**81.45**		**8.40**		**153.90**		**50.20**		**15.25**		**2,535.35**		**8.80**		**1.00**		**3.45**		**6.35**		**10.00**		**30.90**	
	Average for Year 1		**29.65**		**1.10**		**74.80**		**22.90**		**1.70**		**754.80**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**3.09**		**0.22**		**6.47**		**2.25**		**1.00**		**38.32**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**27.43**		**1.70**		**104.81**		**37.37**		**1.52**		**516.95**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**20.72**		**1.34**		**45.70**		**20.27**		**1.10**		**380.70**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 5		**21.03**		**1.17**		**29.35**		**1.85**		**1.83**		**220.10**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Postrem. Average		**20.38**		**1.11**		**52.23**		**16.93**		**1.43**		**382.17**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
Spatial Unit 5 Ditches																										
5	R01DH049	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	4.40	*	0.60	*	1.00	*	13.00	*	NS		NS		NS		NS		NS		NS	
		Year 3	62.40		9.10		150.00		51.60		1.50	*	2,290.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	1.30	*	2.10	*	1.10	*	4.60	*	NS		NS		NS		NS		NS		NS	
		Year 5	47.70		2.60		53.10		26.20		1.70	*	644.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 5 Ditches (Continued)																										
5	R01DH057	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.90		0.15	*	9.30	*	2.10		1.00	*	59.70		NS		NS		NS		NS		NS		NS	
		Year 3	120.00		0.60	*	83.20		39.30		1.50	*	826.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	3.00	*	6.20	*	1.10	*	23.00	*	NS		NS		NS		NS		NS		NS	
		Year 5	40.70		2.60		85.30		45.30		7.60		838.00		NS		NS		NS		NS		NS		NS	
5	R01DH073	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	31.30		0.15	*	36.20		11.70		1.00	*	184.00		NS		NS		NS		NS		NS		NS	
		Year 3	88.70		0.19	*	7.00	*	3.20	*	1.50	*	103.00		NS		NS		NS		NS		NS		NS	
		Year 4	2.40	*	0.15	*	2.70	*	2.50	*	1.10	*	20.30	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
5	R01DH096	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.35		6.40	*	2.00	*	1.00	*	121.00		NS		NS		NS		NS		NS		NS	
		Year 3	96.40		20.00		460.00		213.00		3.00	*	6,250.00		NS		NS		NS		NS		NS		NS	
		Year 4	4.90	*	0.34		15.20		2.60	*	1.10	*	146.00		NS		NS		NS		NS		NS		NS	
		Year 5	4.90	*	0.20	*	4.10	*	2.30	*	1.30	*	165.00		NS		NS		NS		NS		NS		NS	
5	R01DH117	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	4.60	*	0.50	*	1.00	*	114.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.00	*	1.10	*	8.10	*	1.60	*	0.80	*	657.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.60	*	0.18	*	3.40	*	0.70	*	1.10	*	65.20		NS		NS		NS		NS		NS		NS	
		Year 5	5.80		0.46		8.10		0.50	*	1.30	*	149.00		NS		NS		NS		NS		NS		NS	
5	R01DH124	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	4.60	*	0.50	*	1.00	*	154.00		NS		NS		NS		NS		NS		NS	
		Year 3	0.60	*	0.60	*	5.50	*	0.35	*	0.90	*	403.00		NS		NS		NS		NS		NS		NS	
		Year 4	2.00	*	0.17	*	3.50	*	0.70	*	1.10	*	81.50		NS		NS		NS		NS		NS		NS	
		Year 5	9.10		0.67		9.20		0.50	*	1.30	*	191.00		NS		NS		NS		NS		NS		NS	
5	**Prerem. Average**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 1		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**7.37**		**0.18**		**10.92**		**2.90**		**1.00**		**107.62**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**61.68**		**5.27**		**118.97**		**51.51**		**1.53**		**1,754.83**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**2.18**		**0.19**		**4.85**		**2.47**		**1.10**		**56.77**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 5		**21.64**		**1.31**		**31.96**		**14.96**		**2.64**		**397.40**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
		Postrem. Average	**23.22**		**1.74**		**41.67**		**17.96**		**1.57**		**579.15**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 7 Ditches																										
7	R01DH041	Prerem.	71.50		9.00		160.00		54.00		10.00	*	1,410.00		25.20		1.00	*	1.50	*	8.30		10.00	*	18.50	
		Year 1	29.40		0.32	*	56.80		14.20		2.50	*	422.00		NS		NS		NS		NS		NS		NS	
		Year 2	18.00		0.15	*	13.40	*	2.70		1.00	*	110.00		NS		NS		NS		NS		NS		NS	
		Year 3	31.80		0.36	*	1.40		1.40		1.50	*	0.60		NS		NS		NS		NS		NS		NS	
		Year 4	2.00	*	0.15	*	8.50		7.10	*	1.10	*	39.50		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
7	R01DH067	Prerem.	4,720.00		68.40		1,660.00		616.00		10.00	*	7,930.00		136.00		1.00	*	1.50	*	10.70		10.00	*	16.70	
		Year 1	69.30		0.10	*	13.20		0.80	*	1.70	*	74.90		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	5.40	*	1.30		1.00	*	7.10	*	NS		NS		NS		NS		NS		NS	
		Year 3	318.00		5.40		160.00		45.10		1.50	*	786.00		NS		NS		NS		NS		NS		NS	
		Year 4	125.00		0.41		18.00		3.60		1.10	*	84.30		NS		NS		NS		NS		NS		NS	
		Year 5	197.00		0.15	*	1.30	*	0.90	*	1.30	*	9.10	*	NS		NS		NS		NS		NS		NS	
7	R01DH090	Prerem.	29.90		1.00	*	8.50		5.30		10.00	*	62.40		14.70		1.00	*	3.00		5.10		10.00	*	26.90	
		Year 1	35.20		0.10	*	14.30		1.20	*	1.70	*	40.80	*	NS		NS		NS		NS		NS		NS	
		Year 2	13.00		0.51		21.00		3.20		1.00	*	106.00		NS		NS		NS		NS		NS		NS	
		Year 3	4.30	*	0.19	*	5.20	*	0.70	*	1.50	*	39.70	*	NS		NS		NS		NS		NS		NS	
		Year 4	12.10		0.52		3.40	*	0.70	*	1.10	*	93.10		NS		NS		NS		NS		NS		NS	
		Year 5	7.40		0.15	*	25.60		0.50	*	1.30	*	8.20	*	11.80		0.15	*	7.40		0.50	*	1.30	*	24.50	
7	R01DH092	Prerem.	1,470.00		71.00		1,210.00		383.00		10.00	*	8,250.00		89.00		1.00	*	3.30		8.40		10.00	*	29.90	
		Year 1	20.50		0.10	*	8.40	*	1.80	*	1.70	*	55.50	*	NS		NS		NS		NS		NS		NS	
		Year 2	11.20		2.00		24.10		2.80		1.00	*	215.00		NS		NS		NS		NS		NS		NS	
		Year 3	189.00		10.20		224.00		53.90		2.40	*	1,940.00		NS		NS		NS		NS		NS		NS	
		Year 4	19.50		0.15	*	4.50	*	1.10	*	0.90	*	67.30		NS		NS		NS		NS		NS		NS	
		Year 5	1,500.00		46.50		2,850.00		392.00		6.40	*	9,880.00		109.00		0.15	*	17.30		0.90	*	1.30	*	7.60	*
7	R01DH099	Prerem.	22.90		1.00	*	10.10		7.50		10.00	*	101.00		16.00		1.00	*	6.80		5.80		10.00	*	17.40	
		Year 1	15.60		0.20	*	15.70		0.80	*	1.70	*	606.00		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	8.60	*	3.30		1.00	*	65.90		NS		NS		NS		NS		NS		NS	
		Year 3	5.60	*	0.19	*	7.20	*	1.70	*	1.50	*	36.90	*	NS		NS		NS		NS		NS		NS	
		Year 4	15.10		0.55		4.60	*	1.20	*	1.10	*	108.00		NS		NS		NS		NS		NS		NS	
		Year 5	10.20		0.15	*	8.00		1.00	*	1.30	*	33.70		NS		NS		NS		NS		NS		NS	
7	R01DH100	Prerem.	100.00		3.60		63.00		28.30		10.00	*	362.00		43.70		1.00	*	1.50	*	9.10		10.00	*	33.50	
		Year 1	17.40		0.10	*	13.50		2.90		1.70	*	354.00		NS		NS		NS		NS		NS		NS	
		Year 2	4.40		0.50	*	6.60	*	1.20		1.00	*	46.00		NS		NS		NS		NS		NS		NS	
		Year 3	212.00		10.40		231.00		46.40		3.30	*	1,640.00		NS		NS		NS		NS		NS		NS	
		Year 4	26.00		0.15	*	5.80	*	0.70	*	0.90	*	71.50		NS		NS		NS		NS		NS		NS	
		Year 5	61.60		0.35	*	15.70		0.70	*	1.60	*	105.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 7 Ditches (continued)																										
7	R01DH113	Prerem.	58.60		1.00	*	35.50		14.90		10.00	*	215.00		27.50		1.00	*	3.60		6.90		10.00	*	29.40	
		Year 1	35.90		0.10	*	26.00		2.20	*	1.70	*	103.00		NS		NS		NS		NS		NS		NS	
		Year 2	15.30		0.15	*	35.70		2.70		1.00	*	101.00		NS		NS		NS		NS		NS		NS	
		Year 3	29.10		0.19	*	34.50		2.20	*	1.50	*	177.00		NS		NS		NS		NS		NS		NS	
		Year 4	32.50		0.15	*	10.10	*	0.70	*	1.10	*	77.80		NS		NS		NS		NS		NS		NS	
		Year 5	6.10	*	0.20	*	3.90	*	2.30	*	1.30	*	58.30		NS		NS		NS		NS		NS		NS	
7	R01DH120	Prerem.	209.00		31.70		410.00		72.50		22.50		2,690.00		13.20		1.00	*	13.60		4.80		22.70		56.60	
		Year 1	3.30		0.10	*	7.00		0.80	*	1.70	*	60.00		NS		NS		NS		NS		NS		NS	
		Year 2	17.10		1.00	*	33.00		3.40		1.00	*	215.00		NS		NS		NS		NS		NS		NS	
		Year 3	226.00		18.80		407.00		81.40		3.80	*	2,740.00		NS		NS		NS		NS		NS		NS	
		Year 4	20.90		0.46		9.30	*	2.00		1.10	*	77.80		NS		NS		NS		NS		NS		NS	
		Year 5	2,970.00		207.00		7,240.00		1,330.00		3.90	*	31,100.00		NS		NS		NS		NS		NS		NS	
7	R01DH121	Prerem.	41.80		32.90		128.00		39.60		10.00	*	14,100.00		1.00	*	10.20		4.60		7.20		10.00	*	#######	
		Year 1	58.80		9.70		198.00		44.70		1.70	*	2,680.00		NS		NS		NS		NS		NS		NS	
		Year 2	7.90		0.70	*	35.50		6.00		1.00	*	387.00		NS		NS		NS		NS		NS		NS	
		Year 3	325.00		58.60		877.00		215.00		3.80	*	17,000.00		NS		NS		NS		NS		NS		NS	
		Year 4	8.60		2.00		8.20	*	0.70	*	1.10	*	111.00		NS		NS		NS		NS		NS		NS	
		Year 5	63.00		5.20		113.00				3.80	*	1,100.00		15.80		0.15	*	22.40		1.70	*	1.30	*	27.60	*
7	R01DH240	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	29.20		0.50	*	9.00	*	1.80		1.00	*	69.50		NS		NS		NS		NS		NS		NS	
		Year 3	146.00		1.60	*	146.00		27.80		1.50	*	860.00		NS		NS		NS		NS		NS		NS	
		Year 4	52.00		0.15	*	8.10		0.50	*	0.90	*	52.30		NS		NS		NS		NS		NS		NS	
		Year 5	1,120.00		29.20		1,540.00		278.00		14.10		6,730.00		NS		NS		NS		NS		NS		NS	
7	R01DH241	Prerem.	15.80		1.00	*	18.10		7.10		10.00	*	178.00		5.70		1.00	*	5.10		5.80		10.00	*	61.30	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	5.50	*	0.50	*	1.00	*	66.40		NS		NS		NS		NS		NS		NS	
		Year 3	110.00		0.19	*	15.50	*	5.00		1.50	*	171.00		NS		NS		NS		NS		NS		NS	
		Year 4	3.30		0.15	*	4.60	*	1.10	*	1.10	*	8.80	*	NS		NS		NS		NS		NS		NS	
		Year 5	113.00		0.15	*	2.50	*	0.90	*	1.30	*	25.90	*	NS		NS		NS		NS		NS		NS	
7	R01DH248	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	7.70		0.28	*	13.50	*	8.90		1.00	*	114.00		NS		NS		NS		NS		NS		NS	
		Year 3	187.00		0.38	*	210.00		108.00		3.00	*	485.00		NS		NS		NS		NS		NS		NS	
		Year 4	3.40		0.15	*	2.30	*	6.30		1.10	*	29.20		NS		NS		NS		NS		NS		NS	
		Year 5	59.50		0.15	*	27.40		NS		2.90	*	192.00		NS		NS		NS		NS		NS		NS	

ATTACHMENT D2

SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 7 Ditches (continued)																										
7	R01DH249	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	3.10	*	1.40		1.00	*	9.20	*	NS		NS		NS		NS		NS		NS	
		Year 3	4.90	*	0.12	*	10.70	*	2.50	*	0.80	*	100.00		NS		NS		NS		NS		NS		NS	
		Year 4	6.20		0.15	*	4.30	*	3.10		1.10	*	13.70		NS		NS		NS		NS		NS		NS	
		Year 5	4.60		0.27	*	7.20		2.50	*	1.30	*	114.00		NS		NS		NS		NS		NS		NS	
7	R01DH250	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	7.30		0.50	*	5.50	*	4.80		1.00	*	51.80		NS		NS		NS		NS		NS		NS	
		Year 3	4.20	*	0.19	*	9.80	*	1.50	*	1.50	*	24.60	*	NS		NS		NS		NS		NS		NS	
		Year 4	5.20	*	0.15	*	3.70	*	0.90	*	1.10	*	54.00		NS		NS		NS		NS		NS		NS	
		Year 5	57.10		0.62		21.00		3.00	*	1.30	*	148.00		NS		NS		NS		NS		NS		NS	
7	R01DH259	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	5.20	*	2.10		1.00	*	39.80		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	0.19	*	5.90	*	0.70	*	1.50	*	89.40		NS		NS		NS		NS		NS		NS	
		Year 4	4.50	*	0.15	*	6.60	*	0.80	*	1.10	*	56.60		NS		NS		NS		NS		NS		NS	
		Year 5	42.80		0.80	*	35.50		16.60		4.00		276.00		NS		NS		NS		NS		NS		NS	
7	R01DH260	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	7.50	*	2.20		1.00	*	44.60		NS		NS		NS		NS		NS		NS	
		Year 3	2.70	*	0.19	*	5.10	*	0.70	*	1.50	*	105.00		NS		NS		NS		NS		NS		NS	
		Year 4	14.00		0.15	*	6.00	*	4.80	*	1.10	*	86.10		NS		NS		NS		NS		NS		NS	
		Year 5	42.80		0.50	*	24.80		5.60	*	1.30	*	190.00		NS		NS		NS		NS		NS		NS	
7	R01DH261	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.50		0.50	*	10.10	*	0.50	*	1.00	*	53.30		NS		NS		NS		NS		NS		NS	
		Year 3	140.00		4.70		199.00		56.10		3.00	*	1,390.00		NS		NS		NS		NS		NS		NS	
		Year 4	178.00		2.10		233.00		114.00		1.10	*	1,330.00		NS		NS		NS		NS		NS		NS	
		Year 5	7.10	*	0.16	*	3.40	*	3.70	*	1.30	*	60.70		NS		NS		NS		NS		NS		NS	
7	R01DH263	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.00		0.50	*	8.80	*	3.20		1.00	*	47.20		NS		NS		NS		NS		NS		NS	
		Year 3	16.20		1.20	*	48.00		13.50		3.50	*	666.00		NS		NS		NS		NS		NS		NS	
		Year 4	43.10		1.40		72.20		65.50		1.10	*	315.00		NS		NS		NS		NS		NS		NS	
		Year 5	49.40		0.31	*	29.50		3.50	*	3.30		156.00		25.80		0.15	*	15.90		0.90	*	1.30	*	8.00	*

ATTACHMENT D2

SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 7 Ditches (continued)																										
7	R01DH265	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		Y7	
		Year 2	2.00	*	0.49	*	3.80	*	0.50	*	1.00	*	158.00		NS		NS		NS		NS		NS		NS	
		Year 3	29.60		5.30		107.00		0.70	*	1.90	*	7,380.00		NS		NS		NS		NS		NS		NS	
		Year 4	20.60		0.87		9.00	*	0.50	*	0.90	*	119.00		NS		NS		NS		NS		NS		NS	
		Year 5	144.00		17.70		201.00		4.70	*	4.40		1,690.00		78.80		0.33		139.00		1.70	*	1.30	*	0.50	*
7	R01DH266	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	42.00		3.80		29.80		2.00		1.00	*	807.00		NS		NS		NS		NS		NS		NS	
		Year 3	2,610.00		126.00		3,640.00		657.00		3.00	*	19,700.00		NS		NS		NS		NS		NS		NS	
		Year 4	15.20		0.15	*	7.40	*	0.90	*	1.10	*	62.10		NS		NS		NS		NS		NS		NS	
		Year 5	8.10	*	2.30		3.20	*	25.40		1.30	*	83.00		7.40	*	0.50	*	1.70	*	2.50	*	1.30	*	31.60	
7	**Prerem. Average**		**673.95**		**22.06**		**370.32**		**122.82**		**11.25**		**3,529.84**		**37.20**		**1.92**		**4.45**		**7.21**		**11.27**		**1,169.02**	
	Average for Year 1		**31.71**		**1.20**		**39.21**		**7.71**		**1.79**		**488.47**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**9.93**		**0.68**		**14.26**		**2.73**		**1.00**		**135.69**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**229.70**		**12.22**		**317.22**		**66.07**		**2.18**		**2,766.56**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**30.36**		**0.51**		**21.48**		**10.81**		**1.06**		**142.86**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 5		**340.19**		**16.41**		**639.63**		**121.84**		**3.02**		**2,734.73**		**41.43**		**0.24**		**33.95**		**1.37**		**1.30**		**16.63**	
	Postrem. Average		**128.38**		**6.20**		**206.36**		**41.83**		**1.81**		**1,253.66**		**41.43**		**0.24**		**33.95**		**1.37**		**1.30**		**16.63**	
Spatial Unit 9 Slough																										
9	R01SH015	Prerem.	2.70		1.00	*	13.30		5.10		10.00	*	24.40		1.00	*	1.00	*	8.30		4.50		10.00	*	6.00	*
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	7.10		0.15	*	7.80	*	1.90		1.00	*	65.20		NS		NS		NS		NS		NS		NS	
		Year 3	1.00	*	0.19	*	5.80	*	1.80	*	1.50	*	4.30	*	NS		NS		NS		NS		NS		NS	
		Year 4	2.50	*	0.15	*	2.60	*	1.20	*	1.10	*	4.50	*	NS		NS		NS		NS		NS		NS	
		Year 5	2.00	*	0.15	*	4.90	*	2.40	*	1.30	*	104.00		NS		NS		NS		NS		NS		NS	
9	R01SH023	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	1.30	*	0.10	*	4.60	*	0.80	*	0.80	*	11.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	5.10		0.90	*	1.10	*	9.50		1.20	*	0.15	*	3.10		0.90	*	1.10	*	79.90	
		Year 5	31.20		0.90	*	99.20		57.00		5.60	*	345.00		NS		NS		NS		NS		NS		NS	
9	R01SH028	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.80		0.50	*	2.10	*	1.80		1.00	*	49.40		NS		NS		NS		NS		NS		NS	
		Year 3	1.10	*	0.10	*	5.50	*	0.35	*	1.90	*	30.20		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	6.30		0.70	*	1.10	*	38.50		1.10	*	0.15	*	4.20		0.90	*	1.10	*	21.90	*
		Year 5	7.50		0.30	*	11.60		3.60	*	2.40	*	104.00		NS		NS		NS		NS		NS		NS	

ATTACHMENT D2

SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 9 Slough (continued)																										
9	R01SH029	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	8.70		0.15	*	18.00	*	5.40		1.00	*	74.40		NS		NS		NS		NS		NS		NS	
		Year 3	1.70	*	0.10	*	5.70	*	0.90	*	0.80	*	36.40		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	6.70		0.70	*	1.10	*	39.80		1.10	*	0.15	*	4.50		0.70	*	1.10	*	58.40	
		Year 5	1.80	*	0.15	*	4.10	*	0.90	*	1.30	*	23.10	*	NS		NS		NS		NS		NS		NS	
9	R01SH033	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	6.70	*	1.70		1.70	*	57.10		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	0.19	*	9.70	*	0.70	*	2.30	*	116.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	2.30	*	0.70	*	1.10	*	6.30	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH206	Prerem.	9.30		1.00	*	29.30		9.40		10.00	*	102.00		1.00	*	1.00	*	5.70		4.00		10.00	*	41.30	
		Year 1	1.40	*	0.10	*	5.00	*	2.50		1.70	*	224.00		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	3.00	*	0.50	*	1.30	*	13.80	*	NS		NS		NS		NS		NS		NS	
		Year 3	1.00	*	0.19	*	4.80	*	0.70	*	2.00	*	7.00	*	NS		NS		NS		NS		NS		NS	
		Year 4	1.90	*	0.15	*	3.10	*	1.20	*	1.10	*	32.80		NS		NS		NS		NS		NS		NS	
		Year 5	3.00	*	0.15	*	4.30	*	2.50	*	1.30	*	22.30	*	1.40	*	0.15	*	21.40		0.90	*	1.30	*	8.50	*
9	R01SH219	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	3.30	*	0.50	*	1.00	*	13.60	*	NS		NS		NS		NS		NS		NS	
		Year 3	2.10	*	0.19	*	6.00	*	1.40	*	1.50	*	8.20	*	NS		NS		NS		NS		NS		NS	
		Year 4	2.50	*	0.15	*	2.80	*	0.90	*	1.10	*	27.30		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH220	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.60		1.50	*	6.60	*	3.00		1.00	*	44.60		NS		NS		NS		NS		NS		NS	
		Year 3	1.00	*	0.19	*	8.20	*	0.70	*	1.50	*	5.40	*	NS		NS		NS		NS		NS		NS	
		Year 4	2.60		0.15	*	2.70	*	0.90	*	1.10	*	11.60		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH221	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	8.20	*	1.70		1.00	*	81.30		NS		NS		NS		NS		NS		NS	
		Year 3	3.30	*	0.19	*	5.70	*	0.70	*	1.50	*	11.50	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.00		0.15	*	6.90		0.90	*	1.10	*	19.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 9 Slough (continued)																										
9	R01SH222	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	8.00	*	3.50		1.00	*	78.30		NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.19	*	5.40	*	0.70	*	1.50	*	4.20	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.10		0.15	*	9.00		1.20	*	1.10	*	36.20		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH223	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.50		0.15	*	10.00	*	2.80		1.20	*	90.60		NS		NS		NS		NS		NS		NS	
		Year 3	1.00	*	0.19	*	5.90	*	0.70	*	1.50	*	6.40	*	NS		NS		NS		NS		NS		NS	
		Year 4	1.50	*	0.15	*	2.10	*	0.90	*	1.10	*	6.10	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH224	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.60		0.15	*	12.10	*	4.40		1.00	*	96.80		NS		NS		NS		NS		NS		NS	
		Year 3	1.90	*	0.10	*	5.00	*	0.90	*	2.00	*	3.90	*	NS		NS		NS		NS		NS		NS	
		Year 4	6.30		0.15	*	11.10		0.60	*	1.10	*	40.20		NS		NS		NS		NS		NS		NS	
		Year 5	2.30	*	0.15	*	9.90		2.20	*	1.30	*	32.10		NS		NS		NS		NS		NS		NS	
9	R01SH225	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.50		0.50	*	6.20	*	4.00		1.00	*	37.70		NS		NS		NS		NS		NS		NS	
		Year 3	1.90	*	0.19	*	6.80	*	0.70	*	3.40	*	190.00		NS		NS		NS		NS		NS		NS	
		Year 4	3.20		0.15	*	1.40	*	0.70	*	1.10	*	5.90	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH226	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	3.30	*	1.70	*	1.00	*	9.90	*	NS		NS		NS		NS		NS		NS	
		Year 3	9.10		0.19	*	4.90	*	0.70	*	2.50	*	33.30	*	NS		NS		NS		NS		NS		NS	
		Year 4	4.10		0.15	*	1.30	*	0.70	*	1.10	*	17.10		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH227	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	7.70	*	1.80		1.00	*	10.30	*	NS		NS		NS		NS		NS		NS	
		Year 3	6.20	*	0.19	*	39.00		12.30		1.50	*	132.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	1.70	*	4.10		1.10	*	6.50	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 9 Slough (continued)																										
9	R01SH228	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	7.10		0.15	*	20.20	*	6.40		1.70	*	154.00		NS		NS		NS		NS		NS		NS	
		Year 3	14.50		0.19	*	48.00		12.30		1.50	*	233.00		NS		NS		NS		NS		NS		NS	
		Year 4	4.10		0.15	*	3.00	*	2.10		1.10	*	80.10		NS		NS		NS		NS		NS		NS	
		Year 5	7.50		0.33		10.80		5.10		1.30	*	91.90		5.00		0.15	*	28.40		0.50	*	1.30	*	21.10	
9	R01SH229	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.20		0.15	*	5.20	*	2.60		1.50	*	77.20		NS		NS		NS		NS		NS		NS	
		Year 3	3.00	*	0.19	*	7.10	*	0.70	*	1.80	*	26.70	*	NS		NS		NS		NS		NS		NS	
		Year 4	4.90		0.15	*	5.10		0.60	*	1.10	*	22.80		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH230	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.30		0.15	*	7.20	*	2.10		1.00	*	73.60		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	4.90		0.15	*	5.60		0.60	*	1.10	*	24.40		NS		NS		NS		NS		NS		NS	
		Year 5	1.50	*	0.15	*	10.40		2.80	*	1.30	*	15.30	*	NS		NS		NS		NS		NS		NS	
9	R01SH231	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	5.20	*	1.30	*	1.00	*	9.40	*	NS		NS		NS		NS		NS		NS	
		Year 3	24.60		0.19	*	35.80		11.20		2.10	*	176.00		NS		NS		NS		NS		NS		NS	
		Year 4	6.00		0.15	*	6.10		0.60	*	1.10	*	25.70		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
9	R01SH234	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	8.80	*	3.40		1.00	*	71.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	0.19	*	5.40	*	0.70	*	4.30	*	36.30	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.40		14.60		2.10	*	0.70	*	1.10	*	5.90	*	NS		NS		NS		NS		NS		NS	
		Year 5	6.20		0.15	*	9.20		2.50	*	1.30	*	85.50		3.90		0.15	*	27.40		0.50	*	1.30	*	27.40	
9	R01SH235	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.50		0.15	*	7.00	*	2.00		1.00	*	58.80		NS		NS		NS		NS		NS		NS	
		Year 3	3.50	*	0.19	*	5.70	*	0.70	*	1.50	*	41.30	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.80		0.15	*	1.70	*	0.70	*	1.10	*	4.30	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 9 Slough (continued)																										
9	**Prerem. Average**		**6.00**		**1.00**		**21.30**		**7.25**		**10.00**		**63.20**		**1.00**		**1.00**		**7.00**		**4.25**		**10.00**		**23.65**	
	Average for Year 1		**1.40**		**0.10**		**5.00**		**2.50**		**1.70**		**224.00**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**4.05**		**0.25**		**7.83**		**2.63**		**1.12**		**58.35**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**4.28**		**0.17**		**11.25**		**2.48**		**1.87**		**55.66**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**3.01**		**0.84**		**4.22**		**1.03**		**1.10**		**22.12**		**1.13**		**0.15**		**3.93**		**0.83**		**1.10**		**53.40**	
	Average for Year 5		**7.00**		**0.27**		**18.27**		**8.78**		**1.90**		**91.47**		**3.43**		**0.15**		**25.73**		**0.63**		**1.30**		**19.00**	
		Postrem. Average	**3.95**		**0.33**		**9.31**		**3.48**		**1.54**		**90.32**		**2.28**		**0.15**		**14.83**		**0.73**		**1.20**		**36.20**	
Spatial Unit 10 Slough																										
10	R01SH046	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.90		0.15	*	8.30	*	2.20		1.00	*	34.30		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	0.19	*	21.70		2.30	*	1.50	*	25.30	*	NS		NS		NS		NS		NS		NS	
		Year 4	2.60	*	0.18	*	3.40	*	0.70	*	1.10	*	44.70		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH050	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.60		0.15	*	11.40	*	1.80		1.00	*	61.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.90	*	0.19	*	4.80	*	0.70	*	1.50	*	32.80	*	NS		NS		NS		NS		NS		NS	
		Year 4	2.10	*	1.20	*	3.40	*	0.70	*	1.10	*	44.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH051	Prerem.	10.10		1.00	*	14.40		4.50		1.10	*	147.00		6.00		1.00	*	6.60		4.00		1.10	*	62.00	
		Year 1	1.50	*	0.10	*	4.80	*	0.80	*	2.70	*	90.20		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	13.20	*	3.30		1.00	*	88.00		NS		NS		NS		NS		NS		NS	
		Year 3	3.50	*	0.19	*	6.30	*	0.70	*	1.50	*	25.80	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.70	*	0.15	*	3.80	*	0.70	*	1.10	*	54.40		NS		NS		NS		NS		NS		NS	
		Year 5	5.60	*	0.15	*	12.00		9.80		1.30	*	130.00		NS		NS		NS		NS		NS		NS	
10	R01SH058	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	9.70	*	4.10		1.00	*	97.20		NS		NS		NS		NS		NS		NS	
		Year 3	4.70	*	0.19	*	5.80	*	1.90	*	1.50	*	27.90	*	NS		NS		NS		NS		NS		NS	
		Year 4	21.00		0.22	*	18.70		2.10	*	1.10	*	116.00		NS		NS		NS		NS		NS		NS	
		Year 5	17.40		0.33		19.50		3.20	*	1.30	*	127.00		NS		NS		NS		NS		NS		NS	
10	R01SH074	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	11.90	*	1.90		1.00	*	25.80		NS		NS		NS		NS		NS		NS	
		Year 3	1.50	*	0.10	*	4.70	*	0.35	*	0.80	*	28.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.60	*	0.15	*	5.60		1.30	*	1.10	*	20.20	*	1.10	*	0.15	*	5.70		2.80	*	1.10	*	133.00	
		Year 5	1.40	*	0.44		6.70		3.20		1.30	*	88.20		5.30		0.15	*	25.60		0.50	*	1.30	*	22.10	*

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 10 Slough (continued)																										
10	R01SH075	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	8.30	*	1.80		1.00	*	28.20		NS		NS		NS		NS		NS		NS	
		Year 3	2.10	*	0.10	*	7.70	*	0.70	*	0.80	*	24.50		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	3.00	*	1.10	*	1.10	*	21.40	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH077	Prerem.	14.20		1.00	*	10.40		7.70		10.00	*	71.20		9.30		1.00	*	39.70		5.70		10.00	*	74.50	
		Year 1	5.20		0.10	*	8.00		0.80	*	1.70	*	89.30		NS		NS		NS		NS		NS		NS	
		Year 2	8.20		0.15	*	16.60		3.10		1.00	*	87.30		NS		NS		NS		NS		NS		NS	
		Year 3	4.40	*	0.11	*	4.70	*	0.90	*	0.80	*	60.30		NS		NS		NS		NS		NS		NS	
		Year 4	39.30		0.23	*	30.20		4.10	*	1.10	*	212.00		NS		NS		NS		NS		NS		NS	
		Year 5	239.00		23.50		900.00		280.00		8.50		6,710.00		5.30	*	0.15	*	1.50	*	0.90	*	1.30	*	20.50	
10	R01SH098	Prerem.	9.90		1.00	*	10.20		6.20		1.10	*	203.00		4.40		2.10		6.30		5.20		1.10	*	102.00	
		Year 1	1.40	*	0.10	*	4.40	*	1.90	*	1.70	*	29.70	*	NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	5.10	*	1.90		1.00	*	35.50		NS		NS		NS		NS		NS		NS	
		Year 3	1.30	*	0.19	*	5.70	*	0.70	*	1.50	*	76.00		NS		NS		NS		NS		NS		NS	
		Year 4	10.70		0.15	*	18.40		0.80	*	1.10	*	140.00		NS		NS		NS		NS		NS		NS	
		Year 5	17.40		0.37		18.10		2.50	*	1.90	*	123.00		NS		NS		NS		NS		NS		NS	
10	R01SH105	Prerem.	6.80		2.70		11.70		4.80		1.10	*	227.00		3.00		2.40		9.30		2.70		1.10	*	94.30	
		Year 1	1.40	*	0.10	*	3.90	*	0.80	*	1.70	*	18.20	*	NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	6.00	*	4.60		1.00	*	131.00		NS		NS		NS		NS		NS		NS	
		Year 3	1.70	*	0.19	*	5.10	*	0.70	*	1.60	*	72.00		NS		NS		NS		NS		NS		NS	
		Year 4	14.40		1.50		15.90		1.40	*	1.10	*	136.00		NS		NS		NS		NS		NS		NS	
		Year 5	14.20		0.76		31.20		2.50	*	3.00		237.00		NS		NS		NS		NS		NS		NS	
10	R01SH111	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.70		0.25	*	8.50	*	6.20		1.80	*	208.00		NS		NS		NS		NS		NS		NS	
		Year 3	25.40		0.19	*	7.60	*	1.90	*	1.50	*	166.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.38	*	2.00	*	2.40	*	1.10	*	20.70	*	NS		NS		NS		NS		NS		NS	
		Year 5	6.20		0.30		12.00		5.40		1.30	*	145.00		NS		NS		NS		NS		NS		NS	
10	R01SH112	Prerem.	6.80		3.90		14.40		6.70		1.10	*	232.00		5.70		1.00	*	7.50		3.70		1.10	*	99.50	
		Year 1	1.50	*	0.10	*	3.60	*	0.80	*	1.70	*	22.80	*	NS		NS		NS		NS		NS		NS	
		Year 2	5.20		0.15	*	8.70	*	5.40		1.00	*	117.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.30	*	0.19	*	4.60	*	0.70	*	1.50	*	72.20		NS		NS		NS		NS		NS		NS	
		Year 4	4.20	*	0.15	*	9.50		5.40	*	1.10	*	41.20		NS		NS		NS		NS		NS		NS	
		Year 5	3.70		0.70		29.20		2.50	*	1.30	*	214.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 10 Slough (continued)																										
10	R01SH118	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	8.40	*	5.40		1.00	*	120.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.20	*	0.23	*	4.60	*	0.90	*	0.80	*	85.50		NS		NS		NS		NS		NS		NS	
		Year 4	4.00	*	0.15	*	4.30	*	0.90	*	1.10	*	49.50		2.80	*	0.15	*	4.20	*	0.90	*	1.10	*	149.00	
		Year 5	10.20		0.76		29.00		2.50	*	1.30	*	263.00		2.80		0.15	*	35.80		0.70	*	1.30	*	20.90	*
10	R01SH130	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.20		0.15	*	9.30	*	7.20		1.00	*	192.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.80	*	0.19	*	5.20	*	0.70	*	1.50	*	82.50		NS		NS		NS		NS		NS		NS	
		Year 4	2.30	*	0.15	*	9.10		0.70	*	1.10	*	56.50		NS		NS		NS		NS		NS		NS	
		Year 5	5.50	*	0.35	*	10.10		1.00	*	1.30	*	145.00		NS		NS		NS		NS		NS		NS	
10	R01SH131	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.40		0.50	*	6.10	*	2.40		1.00	*	76.70		NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.16	*	4.60	*	1.30	*	0.80	*	103.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.60	*	0.15	*	10.30		3.20	*	1.10	*	37.40	*	1.60	*	0.15	*	8.70		1.00	*	1.10	*	37.20	*
		Year 5	4.10		0.15	*	2.40	*	1.70		1.30	*	85.00		NS		NS		NS		NS		NS		NS	
10	R01SH132	Prerem.	4.10		1.00	*	6.50		4.10		1.10	*	339.00		2.40		1.00	*	5.50		3.10		1.10	*	175.00	
		Year 1	1.40	*	0.10	*	3.50	*	0.80	*	1.70	*	29.50	*	NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.42		25.50		1.80	*	1.00	*	177.00		NS		NS		NS		NS		NS		NS	
		Year 3	5.40		0.20	*	6.60	*	1.10	*	0.80	*	111.00		NS		NS		NS		NS		NS		NS	
		Year 4	6.30		0.68		22.30		4.30	*	1.10	*	247.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH133	Prerem.	5.80		1.00	*	9.60		4.50		1.10	*	289.00		3.00		1.00	*	3.10		1.90		5.80		158.00	
		Year 1	29.80		3.20		116.00		51.50		1.70	*	1,440.00		NS		NS		NS		NS		NS		NS	
		Year 2	5.00		0.15	*	3.50	*	0.50	*	1.00	*	181.00		NS		NS		NS		NS		NS		NS	
		Year 3	300.00		24.60		700.00		490.00		0.80	*	10,700.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.20	*	0.15	*	8.70		1.80	*	1.10	*	39.30	*	NS		NS		NS		NS		NS		NS	
		Year 5	3.80		0.35		2.70	*	3.20		1.30	*	85.90		6.50		0.15	*	29.70		0.50	*	1.30	*	62.10	
10	R01SH134	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	4.10	*	0.50	*	1.00	*	69.60		NS		NS		NS		NS		NS		NS	
		Year 3	2.20	*	0.15	*	5.40	*	0.35	*	0.80	*	68.70		NS		NS		NS		NS		NS		NS	
		Year 4	3.90	*	0.15	*	4.80	*	1.00	*	1.10	*	71.60		3.20	*	0.15	*	4.20	*	0.80	*	1.10	*	124.00	
		Year 5	6.70		0.15	*	2.50	*	1.40		1.30	*	64.90		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 10 Slough (continued)																										
10	R01SH236	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.00		0.15	*	8.40	*	2.90		1.00	*	51.60		NS		NS		NS		NS		NS		NS	
		Year 3	3.80	*	0.19	*	6.50	*	0.70	*	1.50	*	32.90	*	NS		NS		NS		NS		NS		NS	
		Year 4	2.70	*	0.80	*	3.50	*	0.70	*	1.10	*	41.90		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH237	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	7.30	*	3.30		1.00	*	118.00		NS		NS		NS		NS		NS		NS	
		Year 3	4.40	*	0.19	*	5.60	*	1.90	*	1.50	*	17.40	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.10		0.15	*	4.60	*	2.30	*	1.10	*	24.70	*	NS		NS		NS		NS		NS		NS	
		Year 5	3.80	*	0.40		11.00		0.90	*	1.30	*	27.50	*	NS		NS		NS		NS		NS		NS	
10	R01SH239	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	4.70	*	2.10		1.00	*	97.50		NS		NS		NS		NS		NS		NS	
		Year 3	1.60	*	0.10	*	5.40	*	0.35	*	1.60		10.60	*	NS		NS		NS		NS		NS		NS	
		Year 4	1.70	*	0.15	*	9.30		0.90	*	1.10	*	59.40		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH243	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	7.00	*	0.70	*	1.40	*	44.80		NS		NS		NS		NS		NS		NS	
		Year 3	1.80	*	0.10	*	4.80	*	0.35	*	0.80	*	26.20	*	NS		NS		NS		NS		NS		NS	
		Year 4	1.30	*	0.15	*	9.60		1.20	*	1.10	*	68.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	R01SH257	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.50	*	3.80	*	3.10		1.00	*	98.60		NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.10	*	5.30	*	0.35	*	0.80	*	14.60	*	NS		NS		NS		NS		NS		NS	
		Year 4	10.90		0.33		17.10		1.40	*	1.10	*	126.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
10	**Prerem. Average**		**8.24**		**1.66**		**11.03**		**5.50**		**2.37**		**215.46**		**4.83**		**1.36**		**11.14**		**3.76**		**3.04**		**109.33**	
	Average for Year 1		**6.03**		**0.54**		**20.60**		**8.20**		**1.84**		**245.67**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**3.33**		**0.23**		**8.90**		**3.01**		**1.05**		**97.28**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**17.33**		**1.27**		**37.85**		**23.16**		**1.19**		**539.24**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**6.40**		**0.34**		**9.89**		**1.78**		**1.10**		**76.00**		**2.18**		**0.15**		**5.70**		**1.38**		**1.10**		**110.80**	
	Average for Year 5		**24.21**		**2.05**		**77.60**		**22.84**		**1.98**		**603.25**		**4.98**		**0.15**		**23.15**		**0.65**		**1.30**		**31.40**	
		Postrem. Average	**11.46**		**0.89**		**30.97**		**11.80**		**1.43**		**312.29**		**3.58**		**0.15**		**14.43**		**1.01**		**1.20**		**71.10**	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 11 Slough																										
11	R01SH055	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	5.90	*	1.30	*	1.00	*	55.80		NS		NS		NS		NS		NS		NS	
		Year 3	86.50		11.90		114.00		70.30		1.50	*	4,750.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	1.50	*	2.30	*	1.10	*	7.40	*	NS		NS		NS		NS		NS		NS	
		Year 5	4.10	*	0.15	*	5.40		0.90	*	1.30	*	103.00		NS		NS		NS		NS		NS		NS	
11	R01SH081	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.60		0.21	*	7.30	*	1.80	*	1.00	*	205.00		NS		NS		NS		NS		NS		NS	
		Year 3	398.00		55.20		656.00		287.00		3.00	*	25,200.00		NS		NS		NS		NS		NS		NS	
		Year 4	9.60		0.44		8.50		0.60	*	1.10	*	64.30		NS		NS		NS		NS		NS		NS	
		Year 5	468.00		107.00		788.00		191.00		4.40	*	33,700.00		NS		NS		NS		NS		NS		NS	
11	R01SH082	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.20		0.15	*	14.60		2.90	*	1.00	*	124.00		NS		NS		NS		NS		NS		NS	
		Year 3	518.00		136.00		1,010.00		479.00		13.40		40,100.00		NS		NS		NS		NS		NS		NS	
		Year 4	1.10	*	0.15	*	3.50		1.80	*	1.10	*	15.40	*	1.10	*	0.15	*	3.40		2.70	*	1.10	*	37.70	*
		Year 5	16.20		0.60	*	26.60		11.40		1.30	*	359.00		NS		NS		NS		NS		NS		NS	
11	R01SH097	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	0.24	*	17.90		2.60	*	1.50	*	97.50	*	NS		NS		NS		NS		NS		NS	
		Year 4	8.10		0.15	*	9.80		0.60	*	1.10	*	87.00		NS		NS		NS		NS		NS		NS	
		Year 5	3.80	*	0.48		16.30		7.60		1.30	*	98.80		2.90	*	0.15	*	33.00		0.90	*	1.30	*	19.60	*
11	R01SH244	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.30		0.20	*	9.90	*	2.10	*	1.00	*	186.00		NS		NS		NS		NS		NS		NS	
		Year 3	3.00	*	0.23	*	4.90	*	0.90	*	0.80	*	166.00		NS		NS		NS		NS		NS		NS	
		Year 4	3.20	*	0.15	*	3.50	*	0.90	*	1.10	*	45.10		NS		NS		NS		NS		NS		NS	
		Year 5	7.90		0.56		13.50		0.50	*	1.40	*	172.00		3.50		0.15	*	32.00		0.50	*	1.30	*	21.90	*
11	R01SH245	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.10		0.38	*	6.70	*	1.00	*	1.00	*	147.00		NS		NS		NS		NS		NS		NS	
		Year 3	12.50		1.10	*	12.30	*	6.60		0.80	*	471.00		NS		NS		NS		NS		NS		NS	
		Year 4	14.40		0.79		16.90		2.60	*	1.10	*	243.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 11 Slough (continued)																										
11	R01SH247	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	18.90		2.00		1.00	*	33.70	*	NS		NS		NS		NS		NS		NS	
		Year 3	3.00	*	0.41	*	6.80	*	2.60	*	1.50	*	414.00		NS		NS		NS		NS		NS		NS	
		Year 4	9.20		0.15	*	8.60		0.60	*	1.10	*	53.80		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
11	R01SH251	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	8.90	*	1.70	*	1.00	*	146.00		NS		NS		NS		NS		NS		NS	
		Year 3	4.20	*	0.80	*	9.30	*	2.10	*	0.80	*	354.00		NS		NS		NS		NS		NS		NS	
		Year 4	4.60	*	0.30		8.30		0.90	*	1.10	*	77.30		NS		NS		NS		NS		NS		NS	
		Year 5	5.30	*	0.15	*	5.70		0.90	*	1.30	*	86.70		3.00		0.15	*	34.00		0.50	*	1.30	*	29.50	*
11	R01SH252	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.90		0.15	*	7.30	*	2.00	*	1.00	*	97.30		NS		NS		NS		NS		NS		NS	
		Year 3	2.60	*	0.60	*	7.10	*	1.50	*	0.80	*	269.00		NS		NS		NS		NS		NS		NS	
		Year 4	9.50		0.15	*	8.50		0.60	*	1.10	*	55.70		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
11	R01SH254	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.60		0.15	*	10.40	*	5.40		1.00	*	167.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.60	*	0.42	*	17.10		2.10	*	1.50	*	186.00		NS		NS		NS		NS		NS		NS	
		Year 4	3.80	*	0.15	*	7.30	*	1.00	*	1.10	*	84.00		NS		NS		NS		NS		NS		NS	
		Year 5	7.10	*	0.27	*	14.00		3.30	*	1.30	*	196.00		NS		NS		NS		NS		NS		NS	
11	R01SH255	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.90		0.15	*	10.30	*	4.20		1.00	*	156.00		NS		NS		NS		NS		NS		NS	
		Year 3	7.00		0.31	*	6.60	*	1.40	*	2.40		190.00		NS		NS		NS		NS		NS		NS	
		Year 4	4.90	*	0.15	*	15.60	*	2.00	*	1.10	*	90.90		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
11	R01SH256	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.20		0.15	*	10.50	*	3.80		1.00	*	131.00		NS		NS		NS		NS		NS		NS	
		Year 3	1.90	*	0.25	*	7.10	*	1.70	*	1.50	*	170.00		NS		NS		NS		NS		NS		NS	
		Year 4	9.30		0.15	*	12.60		0.90	*	1.10	*	94.90		NS		NS		NS		NS		NS		NS	
		Year 5	4.60	*	0.15	*	8.60		0.90	*	1.30	*	120.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 11 Slough (continued)																										
11	**Prerem. Average**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 1		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**4.35**		**0.18**		**10.06**		**2.56**		**1.00**		**131.71**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**86.82**		**17.29**		**155.76**		**71.48**		**2.46**		**6,030.63**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**6.57**		**0.24**		**8.72**		**1.23**		**1.10**		**76.57**		**1.10**		**0.15**		**3.40**		**2.70**		**1.10**		**37.70**	
	Average for Year 5		**64.63**		**13.67**		**109.76**		**27.06**		**1.70**		**4,354.44**		**3.13**		**0.15**		**33.00**		**0.63**		**1.30**		**23.67**	
		Postrem. Average	**40.59**		**7.84**		**71.08**		**25.59**		**1.56**		**2,648.33**		**2.12**		**0.15**		**18.20**		**1.67**		**1.20**		**30.68**	
Spatial Unit 13 Nichols Creek and RASS 3 Pond																										
13	R03DH152	Prerem.	15.30		7.70		36.10		40.60		10.00	*	1,220.00		1.00	*	1.00	*	8.30		5.80		10.00	*	271.00	
		Year 1	3.80		0.10	*	11.10		3.30		1.70	*	1,700.00		NS		NS		NS		NS		NS		NS	
		Year 2	4.70		0.15	*	5.40	*	2.40	*	1.00	*	167.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.20	*	0.10	*	5.00	*	1.10	*	0.80	*	26.40	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.50		0.85		2.30	*	4.70	*	1.10	*	46.00		NS		NS		NS		NS		NS		NS	
		Year 5	1.50	*	0.15	*	1.10	*	0.90	*	1.30	*	55.30		NS		NS		NS		NS		NS		NS	
13	R03SH158	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.10		1.30		0.50	*	2.40		1.00	*	408.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	6.50		0.37		6.00	*	12.90		1.10	*	120.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH159	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	2.40	*	0.15	*	1.30	*	2.70	*	1.10	*	16.00	*	NS		NS		NS		NS		NS		NS	
		Year 5	1.40	*	0.15	*	2.20		1.60	*	1.30	*	168.00		NS		NS		NS		NS		NS		NS	
13	R03SH160	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.96		0.50	*	0.90	*	2.30	*	389.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	6.80		0.34		2.70	*	1.20	*	1.10	*	108.00		NS		NS		NS		NS		NS		NS	
		Year 5	17.90		31.70		150.00		351.00		8.80		13,300.00		1.80	*	0.15	*	20.10		0.90	*	3.40		2.30	*
13	R03SH161	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	1.10		1.10	*	0.50	*	1.70	*	394.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	6.10		0.15	*	1.70	*	0.90	*	1.10	*	18.70	*	NS		NS		NS		NS		NS		NS	
		Year 5	3.70	*	0.15	*	0.60	*	1.40	*	1.30	*	89.20		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 13 Nichols Creek and RASS 3 Pond (continued)																										
13	R03SH162	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.40		1.30		1.70	*	0.50	*	1.80	*	446.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	8.30		1.10		15.20		28.00		1.10	*	515.00		NS		NS		NS		NS		NS		NS	
		Year 5	3.40	*	2.80		9.70		40.20		3.90		1,030.00		NS		NS		NS		NS		NS		NS	
13	R03SH163	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	1.90		36.70		7.90		1.00	*	817.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	4.40		0.15	*	6.00	*	1.20	*	1.10	*	109.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH165	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.70		1.20		2.30	*	0.90	*	1.50	*	438.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	5.70		0.15	*	5.80		0.90	*	1.10	*	35.40		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH169	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.50		1.40		0.50	*	2.00		2.90		444.00		NS		NS		NS		NS		NS		NS	
		Year 3	9.30		0.10	*	19.60	*	5.10	*	0.80	*	33.70	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.10	*	0.15	*	3.50	*	0.90	*	1.10	*	41.00		NS		NS		NS		NS		NS		NS	
		Year 5	4.30	*	4.00		14.20		73.30		3.40	*	1,370.00		NS		NS		NS		NS		NS		NS	
13	R03SH181	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	9.10		2.60		9.90	*	15.40		1.00	*	521.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	2.60	*	0.97		1.80	*	4.40	*	1.10	*	177.00		NS		NS		NS		NS		NS		NS	
		Year 5	1.40	*	0.15	*	1.50	*	2.60	*	2.60	*	157.00		NS		NS		NS		NS		NS		NS	
13	R03SH184	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.80		0.90	*	6.30	*	0.60	*	1.00	*	1,210.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	2.80	*	1.10		12.20		0.70	*	1.10	*	240.00		NS		NS		NS		NS		NS		NS	
		Year 5	3.20		0.15	*	1.40	*	1.80	*	3.30	*	120.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 13 Nichols Creek and RASS 3 Pond (continued)																										
13	R03SH185	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.10		0.70	*	1.10	*	0.50	*	1.00	*	1,120.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	3.00	*	0.64		1.20	*	20.00		1.10	*	52.30		NS		NS		NS		NS		NS		NS	
		Year 5	4.10		0.16	*	2.90	*	2.90	*	3.40	*	354.00		NS		NS		NS		NS		NS		NS	
13	R03SH186	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	249.00		42.50		324.00		3.20	*	105,000.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	3.50	*	0.38	*	5.30	*	0.70	*	1.10	*	251.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH187	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	2.00		0.50	*	1.50	*	1.00	*	610.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	1.20	*	4.10	*	2.20	*	0.80	*	177.00		NS		NS		NS		NS		NS		NS	
		Year 4	3.00	*	0.15	*	1.20	*	0.90	*	1.10	*	43.60		NS		NS		NS		NS		NS		NS	
		Year 5	3.60	*	0.35		10.90		13.30		4.00	*	105.00		NS		NS		NS		NS		NS		NS	
13	R03SH189	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	2.80		0.10	*	2.00	*	0.80	*	1.70	*	606.00		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	0.50	*	0.50	*	1.00	*	16.10	*	NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.10	*	4.40	*	2.00	*	0.80	*	25.70		NS		NS		NS		NS		NS		NS	
		Year 4	9.80		1.10		26.20		14.80	*	1.10	*	144.00		NS		NS		NS		NS		NS		NS	
		Year 5	21.40		4.70		70.50		487.00		6.80	*	1,410.00		NS		NS		NS		NS		NS		NS	
13	R03SH270	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	9.50		0.70	*	27.50		21.30		1.00	*	537.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.10	*	0.19	*	3.60	*	0.70	*	1.50	*	29.60	*	NS		NS		NS		NS		NS		NS	
		Year 4	1.70	*	0.15	*	4.60	*	0.90	*	1.10	*	41.70		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH273	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	54.00		11.20		200.00		117.00		1.50	*	3,140.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	36.00		9.10		111.00		143.00		1.10	*	3,040.00		NS		NS		NS		NS		NS		NS	
		Year 5	20.00		15.30		49.00		186.00		11.20		13,100.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 13 Nichols Creek and RASS 3 Pond (continued)																										
13	R03SH274	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.20		0.15	*	6.60	*	10.70		1.00	*	327.00		NS		NS		NS		NS		NS		NS	
		Year 3	1.00	*	0.19	*	4.70	*	2.50	*	1.50	*	33.30	*	NS		NS		NS		NS		NS		NS	
		Year 4	5.40		0.31		7.70	*	33.90		1.10	*	198.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH275	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	4.20		0.15	*	4.20	*	0.90	*	1.10	*	78.50		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH276	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.70		0.50	*	5.90	*	3.40		1.00	*	627.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	4.30		0.15	*	2.40	*	0.90	*	1.10	*	15.50	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH277	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	4.30		1.60	*	1.30		1.20	*	1,330.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	6.70		1.00		2.30	*	4.10	*	1.10	*	79.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH278	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	3.70	*	0.30		1.50	*	0.90	*	1.10	*	12.60	*	NS		NS		NS		NS		NS		NS	
		Year 5	1.40	*	0.15	*	0.60	*	1.20	*	1.30	*	58.40		NS		NS		NS		NS		NS		NS	
13	R03SH279	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	3.50	*	0.15	*	2.90	*	0.90	*	1.10	*	63.40		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 13 Nichols Creek and RASS 3 Pond (continued)																										
13	R03SH280	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.00		5.70		0.50	*	2.40		1.00	*	1,780.00		NS		NS		NS		NS		NS		NS	
		Year 3	11.80		0.27	*	34.80	*	3.00	*	0.80	*	30.20	*	NS		NS		NS		NS		NS		NS	
		Year 4	3.10	*	0.30		2.80	*	0.90	*	1.10	*	62.00		NS		NS		NS		NS		NS		NS	
		Year 5	72.90		53.20		640.00		1,110.00		17.40		26,500.00		1.40	*	0.15	*	14.50		0.90	*	1.30	*	1.80	*
13	R03SH281	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	3.10	*	0.15	*	4.00	*	0.90	*	1.10	*	42.40		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH282	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	5.50		0.50	*	1.40		2.00	*	1,730.00		NS		NS		NS		NS		NS		NS	
		Year 3	11.10		0.22	*	5.80	*	1.40	*	0.80	*	83.90		NS		NS		NS		NS		NS		NS	
		Year 4	5.60		0.15	*	1.10	*	0.90	*	1.10	*	57.30		NS		NS		NS		NS		NS		NS	
		Year 5	2.70	*	0.15	*	1.90		1.10	*	2.30	*	86.00		NS		NS		NS		NS		NS		NS	
13	R03SH283	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	6.40		0.50	*	2.60		1.10	*	2,080.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	5.70		0.65		2.20	*	4.70	*	1.10	*	151.00		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03SH284	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	4.00		0.15	*	0.70	*	0.50	*	1.10	*	5.50	*	NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	22.60		2.90		122.00		33.00		1.10	*	956.00		NS		NS		NS		NS		NS		NS	
		Year 5	5.20	*	1.00	*	27.90		65.50		6.00	*	790.00		NS		NS		NS		NS		NS		NS	
13	R03SH285	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	0.80	*	0.50	*	1.90	*	3.80	*	NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.11	*	7.90	*	10.40		0.80	*	49.80		NS		NS		NS		NS		NS		NS	
		Year 4	5.60		0.15	*	2.50	*	1.40	*	1.10	*	4.90	*	NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 13 Nichols Creek and RASS 3 Pond (continued)																										
13	R03SH286	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.20		0.15	*	0.50	*	0.50	*	1.00	*	2.50	*	NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.10	*	7.10	*	16.50		0.80	*	73.80		NS		NS		NS		NS		NS		NS	
		Year 4	6.00		0.15	*	1.70	*	0.90	*	1.10	*	4.80	*	NS		NS		NS		NS		NS		NS	
		Year 5	36.80		8.80		398.00		532.00		16.40		3,140.00		NS		NS		NS		NS		NS		NS	
13	R03WD153	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	15.80		2.10	*	1.00	*	177.00		NS		NS		NS		NS		NS		NS	
		Year 3	1.70	*	0.19	*	3.90	*	1.80	*	1.50	*	38.70	*	NS		NS		NS		NS		NS		NS	
		Year 4	4.60		0.15	*	11.10		4.20		1.10	*	92.50		NS		NS		NS		NS		NS		NS	
		Year 5	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
13	R03WD154	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.74		16.70		9.00		1.00	*	288.00		NS		NS		NS		NS		NS		NS	
		Year 3	5.30	*	1.50	*	47.00		37.80		1.50	*	1,100.00		NS		NS		NS		NS		NS		NS	
		Year 4	2.90		0.15	*	4.50	*	0.90	*	1.10	*	25.50	*	1.10	*	0.15	*	3.50	*	0.90	*	1.10	*	20.70	*
		Year 5	1.40	*	0.15	*	1.60	*	1.40	*	1.30	*	103.00		NS		NS		NS		NS		NS		NS	
13	R03WD155	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	6.10		0.15	*	22.10		12.80		1.10	*	357.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.19	*	3.60	*	1.80	*	1.50	*	26.60	*	NS		NS		NS		NS		NS		NS	
		Year 4	4.30		0.15	*	3.90	*	1.70	*	1.10	*	102.00		NS		NS		NS		NS		NS		NS	
		Year 5	19.60		4.30		24.00		96.20		5.10	*	2,300.00		NS		NS		NS		NS		NS		NS	
13	R03WD156	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	24.40		7.30		99.80		97.20		2.40	*	1,970.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	3.50		0.15	*	4.40	*	1.90	*	1.10	*	31.00	*	1.10	*	0.15	*	3.30	*	0.90	*	1.10	*	20.90	*
		Year 5	1.40	*	0.15	*	0.70	*	0.90	*	3.30		16.70	*	1.40	*	0.15	*	14.90		0.90	*	1.30	*	9.70	*
13	R03WD157	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.60	*	6.50	*	2.50		1.00	*	532.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.50	*	0.19	*	3.60	*	1.80	*	1.50	*	161.00		NS		NS		NS		NS		NS		NS	
		Year 4	8.20		1.40		14.90	*	27.70		1.10	*	643.00		NS		NS		NS		NS		NS		NS	
		Year 5	3.00	*	0.70	*	11.10		4.30	*	1.30	*	433.00		NS		NS		NS		NS		NS		NS	

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SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 13 Nichols Creek and RASS 3 Pond (continued)																										
13	UDRSH002	Prerem.	3.40		1.00	*	13.70		9.60		2.50		47.20		2.40		1.00	*	5.50		1.60		2.70		26.20	
		Year 1	28.60		0.10	*	140.00		103.00		13.50		479.00		NS		NS		NS		NS		NS		NS	
		Year 2	7.20		0.15	*	4.40	*	2.70	*	1.00	*	32.20		NS		NS		NS		NS		NS		NS	
		Year 3	2.40	*	0.10	*	3.50	*	1.60	*	0.80	*	4.90	*	NS		NS		NS		NS		NS		NS	
		Year 4	6.30		0.15	*	3.70	*	0.90	*	1.10	*	2.50	*	NS		NS		NS		NS		NS		NS	
		Year 5	8.70	*	0.57		38.20		23.20		5.10	*	118.00		NS		NS		NS		NS		NS		NS	
13	UDRSH006	Prerem.	1.00	*	1.00	*	9.10		1.20		27.70		26.00		2.70		1.00	*	36.90		0.60	*	2.50		37.60	
		Year 1	6.50	*	0.10	*	47.40		33.70		7.40		217.00		NS		NS		NS		NS		NS		NS	
		Year 2	4.60		0.15	*	10.40	*	11.60		1.00	*	58.00		NS		NS		NS		NS		NS		NS	
		Year 3	2.20	*	0.10	*	5.40	*	1.60	*	0.80	*	6.10	*	NS		NS		NS		NS		NS		NS	
		Year 4	6.40		0.15	*	2.20	*	0.90	*	1.10	*	1.90	*	NS		NS		NS		NS		NS		NS	
		Year 5	2.90	*	0.15	*	0.60	*	0.60	*	5.80		2.10	*	4.40	*	0.15	*	41.90		0.90	*	3.10	*	1.70	*
13	UDRSH287	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	5.60		0.15	*	8.80	*	2.90	*	1.40	*	37.90		NS		NS		NS		NS		NS		NS	
		Year 3	13.00		0.38	*	45.60		32.80		1.40	*	155.00		NS		NS		NS		NS		NS		NS	
		Year 4	6.60		0.15	*	4.30	*	0.90	*	1.10	*	3.60	*	NS		NS		NS		NS		NS		NS	
		Year 5	8.00	*	0.98		74.40		42.60		14.00		161.00		NS		NS		NS		NS		NS		NS	
13	**Prerem. Average**		**6.57**		**3.23**		**19.63**		**17.13**		**13.40**		**431.07**		**2.03**		**1.00**		**16.90**		**2.67**		**5.07**		**111.60**	
	Average for Year 1		**10.43**		**0.10**		**50.13**		**35.20**		**6.08**		**750.50**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**6.18**		**9.36**		**16.34**		**20.07**		**1.37**		**3,848.33**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**4.51**		**0.31**		**12.33**		**7.30**		**1.08**		**120.92**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**6.09**		**0.68**		**10.90**		**9.53**		**1.10**		**200.69**		**1.10**		**0.15**		**3.40**		**0.90**		**1.10**		**20.80**	
	Average for Year 5		**10.41**		**5.42**		**63.88**		**126.71**		**5.44**		**2,706.95**		**2.25**		**0.15**		**22.85**		**0.90**		**2.28**		**3.88**	
		Postrem. Average	**7.52**		**3.17**		**30.71**		**39.76**		**3.01**		**1,525.48**		**1.68**		**0.15**		**13.13**		**0.90**		**1.69**		**12.34**	
Spatial Unit 15 RASS 4 Pond																										
15	R04DH195	Prerem.	26.20		4.90		29.20		95.50		21.60		298.00		5.80		1.00	*	4.60		2.60		1.10	*	29.10	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	36.90		3.10		5.80	*	12.80		3.80		298.00		NS		NS		NS		NS		NS		NS	
		Year 3	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 4	181.00		3.60		233.00		476.00		13.80		1,760.00		NS		NS		NS		NS		NS		NS	
		Year 5	86.00		8.80		217.00		510.00		21.10		2,430.00		NS		NS		NS		NS		NS		NS	
15	R04WD199	Prerem.	126.00		16.70		351.00		656.00		29.90		3,740.00		3.50		1.00	*	5.20		2.10		23.50		24.50	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	2.10	*	3.10	*	1.00	*	43.70		NS		NS		NS		NS		NS		NS	
		Year 3	177.00		12.40		1,130.00		876.00		3.80	*	5,500.00		NS		NS		NS		NS		NS		NS	
		Year 4	39.80		1.30		189.00		171.00		1.10	*	827.00		NS		NS		NS		NS		NS		NS	
		Year 5	4.60	*	0.17	*	10.50		2.90	*	1.30	*	51.00		NS		NS		NS		NS		NS		NS	

ATTACHMENT D2

SURFACE WATER RESULTS FOR PRE- AND POSTREMEDIATION MONITORING

			Total Metals												Dissolved Metals											
			Arsenic		Cadmium		Copper		Lead		Selenium		Zinc		Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
Unit	Location	Round	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND	Result	ND
Spatial Unit 15 RASS 4 Pond																										
15	R04WD203	Prerem.	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	4.80	*	6.50		1.00	*	52.00		NS		NS		NS		NS		NS		NS	
		Year 3	3.90	*	0.19	*	38.00		21.00		0.80	*	153.00		NS		NS		NS		NS		NS		NS	
		Year 4	41.40		0.57		169.00		137.00		5.50	*	943.00		NS		NS		NS		NS		NS		NS	
		Year 5	31.40		0.80	*	137.00		82.60		5.50	*	570.00		NS		NS		NS		NS		NS		NS	
15	R04WD204	Prerem.	7.00		1.00	*	14.60		18.20		1.10	*	71.80		5.90		1.00	*	5.50		1.60		1.10	*	21.50	
		Year 1	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
		Year 2	2.00	*	0.15	*	6.90	*	7.00		1.00	*	63.50		NS		NS		NS		NS		NS		NS	
		Year 3	3.20	*	0.10	*	7.40	*	7.60		0.80	*	98.30		NS		NS		NS		NS		NS		NS	
		Year 4	5.10		0.15	*	4.60	*	2.30	*	1.10	*	21.80	*	NS		NS		NS		NS		NS		NS	
		Year 5	2.60	*	0.15	*	4.00		3.10		1.30	*	25.60		NS		NS		NS		NS		NS		NS	
15	R04WD205	Prerem.	8.50		1.00	*	18.90		31.50		1.10	*	115.00		6.40		1.00	*	5.20		2.40		1.10	*	25.40	
		Year 1	1.60	*	0.10	*	2.60	*	2.00		1.70	*	37.50		NS		NS		NS		NS		NS		NS	
		Year 2	12.10		0.15	*	3.80	*	2.70		1.00	*	14.50	*	NS		NS		NS		NS		NS		NS	
		Year 3	261.00		1.00	*	69.60		3.50	*	7.50	*	4.10	*	NS		NS		NS		NS		NS		NS	
		Year 4	5.50		0.15	*	2.80	*	0.90	*	1.10	*	7.00	*	NS		NS		NS		NS		NS		NS	
		Year 5	2.00	*	0.15	*	3.20		5.00		1.30	*	17.30		NS		NS		NS		NS		NS		NS	
15	**Prerem. Average**		**41.93**		**5.90**		**103.43**		**200.30**		**13.43**		**1,056.20**		**5.40**		**1.00**		**5.13**		**2.18**		**6.70**		**25.13**	
	Average for Year 1		**1.60**		**0.10**		**2.60**		**2.00**		**1.70**		**37.50**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 2		**11.00**		**0.74**		**4.68**		**6.42**		**1.56**		**94.34**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 3		**111.28**		**3.42**		**311.25**		**227.03**		**3.23**		**1,438.85**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 4		**54.56**		**1.15**		**119.68**		**157.44**		**4.52**		**711.76**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
	Average for Year 5		**25.32**		**2.01**		**74.34**		**120.72**		**6.10**		**618.78**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	
		Postrem. Average	**40.75**		**1.49**		**102.51**		**102.72**		**3.42**		**580.25**		**NA**		**NA**		**NA**		**NA**		**NA**		**NA**	

Notes:

NA Not applicable; no samples were collected during this year.
ND Not detected
NS No samples were collected from this location during this year.
Postrem. Postremediation
Prerem. Preremediation
RASS Remedial action subsite
* Analyte was not detected, result shown is 1/2 the detection limit

APPENDIX E

EVALUATION OF EXISTING SOURCES AND MIGRATION OF CONTAMINANTS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

(161 Pages)

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E4 BORING AND WELL LOGS

ACRONYMS AND ABBREVIATIONS

^{210}Pb	Lead-210
AOC	Area of concern
AOC1	Area of concern 1
APCL	Applied Physics and Chemistry Laboratory
ATSF	Atchison Topeka Santa Fe Railroad
AWQC	Ambient water quality criteria
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CCC	Criterion continuous concentration
CCMVD	Contra Costa County Mosquito and Vector Control District
CDFG	California Department of Fish and Game
CLP	Contract laboratory program
cm/sec	Centimeter per second
CMS	Corrective measure study
COPC	Chemical of potential concern
CP	Chemically pure
CPC	Chemical and Pigment Company
CRDL	Contract-required detection limit
CWC	Cooper, White, and Cooper, LLP
DHS	California Department of Health Services
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
EDXRF	Energy dispersive x-ray fluorescence
EPA	U.S. Environmental Protection Agency
ER-M	Effects-range median
ES	Environmental Solutions, Inc.
FSP	Field sampling plan
GCC	General Chemical Corporation
Geomatrix	Geomatrix Consultants
gpd	Gallon per day
GTI	Groundwater Technology, Inc.
GWF	G.W.F. Power Systems Company, Inc.
HAR	Hydrogeologic assessment report
HF	Hydrofluoric
HLA	Harding Lawson Associates
Honeywell	Honeywell International
HWMU	Hazardous waste management unit

ACRONYMS AND ABBREVIATIONS (Continued)

ICP	Inductively coupled plasma
IT	International Technology Corporation
L/min	Liter per minute
L/sec	Liter per second
µg/L	Microgram per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
mm/yr	Millimeter per year
MS	Mass spectrometer
msl	Mean sea level
Navy	U.S. Department of the Navy
NWSSBD	Naval Weapons Station, Seal Beach Detachment
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PEA	Preliminary endangerment assessment
ppm	Part per million
ppt	Part per thousand
PRC	PRC Environmental Management, Inc.
PWA	Phillip Williams and Associates, Ltd.
RASS	Remedial action subsite
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RI	Remedial investigation
RPD	Relative percent difference
RWQCB	California Regional Water Quality Control Board
SAP	Sampling and analysis plan
SNR	Sacramento Northern Railroad
SPLP	Synthetic Precipitation Leachate Potential
SPTC	Southern Pacific Transportation Company
SSC	Space and Naval Warfare Systems Center, San Diego
STL	Severn-Trent Laboratories
SWMU	Solid waste management unit
TDS	Total dissolved solids
TOC	Total organic carbon
TPH-g	Total petroleum hydrocarbons as gasoline
TSS	Total suspended solids
TtEMI	Tetra Tech EM Inc.

ACRONYMS AND ABBREVIATIONS (Continued)

UST	Underground storage tank
VOC	Volatile organic compound
WET	Waste extraction test
WES	U.S. Army Corps of Engineers, Waterways Experiment Station
XRF	X-ray fluorescence

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Engineering Field Activity West conducted the first postremediation five-year periodic review assessment at the Litigation Area sites at Naval Weapons Station, Seal Beach Detachment (NWSSBD), Concord, California (Figure 1). The four remedial action subsites (RASS) were the focus of the review (Figure 2). The Navy authorized Tetra Tech EM Inc (TtEMI), formerly PRC Environmental Management, Inc. (PRC), to conduct this review under the Comprehensive Long-term Environmental Action – Navy Contract No. N62474-94-D-7609, Contract Task Order No. 373. As part of this review, the Navy evaluated existing sources and contaminant migration in the Litigation Area. This appendix presents the results of that evaluation.

One of the primary concerns at the Litigation Area marsh is the potential for contaminants at the site to mobilize and contaminate other on-site or off-site areas; migration of contaminants to Suisun Bay is of special concern. Neighboring properties are known to be the original source areas for the metals contaminants found in the Litigation Area. Because contaminants remain in place at these neighboring properties and within the Litigation Area, the potential exists for ongoing migration of contamination in the Litigation Area. A file review was conducted to evaluate the potential for neighboring facilities to act as ongoing sources of contaminants to the Litigation Area. The primary mechanisms of contaminant migration within the site that were evaluated include (1) erosion and mobilization of contaminated soils through surface water in Nichols Creek (Section 3.0), (2) mobilization of contaminated soils from the marsh surface (Section 4.0), (3) mobilization of contaminated sediments from the network of mosquito ditches and sloughs (Section 5.0), (4) migration of contaminants in groundwater to Suisun Bay through Lost Slough (Section 6.0), and (5) migration of contaminated groundwater (Section 7.0). The potential for migration of chemicals through these pathways was investigated by searching files, reviewing monitoring results, and special studies. This appendix addresses contaminant migration to and from the Litigation Area site.

2.0 NEIGHBORING PROPERTIES AS CONTINUING SOURCE AREAS

This section identifies existing sources of chemical contamination at neighboring properties adjacent to the Litigation Area and addresses whether these neighboring properties may be acting as ongoing sources of contamination to the Litigation Area.

During 1997, 2000, and 2001, TtEMI reviewed pertinent and available information in regulatory agency files at the California Environmental Protection Agency, Department of Toxic Substances Control

(DTSC), U.S. Environmental Protection Agency (EPA), and California Regional Water Quality Control Board (RWQCB) for the following former or current neighboring facilities:

- Chemical and Pigment Company (CPC): a manufacturer of various copper- and zinc-based chemicals
- General Chemical Corporation (GCC): a producer of acids, etchants (including sulfuric acid, nitric acid, and hydrofluoric [HF] acid), and alum and a packager of solvents, including 2-propanol, methanol, n-butyl acetate, acetone, and methyl ethyl ketone; this facility was formerly owned by Allied Signal (formerly Allied Chemical Corporation)
- Polypure Inc.: a manufacturer of polymer resins, including "Mannich" and melamine formaldehyde, two families of water treatment polymers
- G.W.F. Power Systems Company, Inc. (GWF): a facility that burns petroleum coke (a byproduct of local crude oil refining operations) supplemented by coal and oil to produce electricity

In addition, potential contamination from railroad companies, including Southern Pacific Transportation Company (SPTC), Atchison Topeka Santa Fe Railroad (ATSF), and Sacramento Northern Railroad (SNR), that own right-of-ways in the Litigation Area is described. The railway right-of-ways include 50 feet on either side of the tracks that run through the Litigation Area (Figure 3). No regulatory agency files of railroad companies were reviewed.

Honeywell International (Honeywell) (formerly Allied Signal) is also a neighboring property that owns waste ponds located immediately east of the Litigation Area wetlands. Regulatory files for this property were not reviewed because this property owner was not known at the time of the file review. Figure 3 presents a map of these properties in relation to the Litigation Area.

This section focuses on CPC and GCC, since these two facilities have the greatest potential for off-site migration of contamination to the Litigation Area because of their proximity to the Navy property boundary and their historic role as sources of the Litigation Area contamination. Section 2.1 through 2.5 present the findings for the CPC; GCC; Honeywell; Polypure, Inc.; and GWF facilities. Section 2.6 presents the findings for the railroad companies.

2.1 CHEMICAL AND PIGMENT COMPANY

The following sections summarize the information collected during the review of CPC agency files, including a brief facility background, a summary of contamination at the site, a regulatory history of the

site, previous remedial actions, and the potential pathways for migration of contaminants to Navy property.

2.1.1 Facility Background

The CPC facility, located at 600 Nichols Road, Pittsburg, California, was constructed in 1962 to recover zinc from galvanizing waste (zinc fines), produce zinc chloride, and manufacture copper sulfates for fungicide sprays. The facility was later used for producing zinc sulfate for agricultural fertilizer or soil amendment (DTSC 2000b). Primary raw materials used in the process include inorganic zinc, sulfuric acid, hydrochloric acid, sodium hydroxide, and ammonia (Environmental Solutions, Inc. [ES] 1987; Groundwater Technology, Inc. [GTI] 1992). The CPC facility consists of 6 buildings, including 3 warehouses, 41 tanks, and mixing equipment and granulators (DTSC 2000b). A timeline of the CPC facility is presented in Attachment E2. CPC ceased operations in March 1999 and is now in Chapter 7 bankruptcy (Cooper, White, and Cooper, LLP [CWC] and 2000).

2.1.2 Contamination

CPC has an extensive history of environmental contamination problems, dating back to 1969 when California Department of Health Services (DHS) filed a criminal complaint against the company for illegal discharge of hazardous waste into waterways (EPA 1985). Environmental investigations at the site since that time have confirmed that elevated concentrations of cadmium, copper, lead, and zinc are present in soils and groundwater at the site. Groundwater contamination detected at CPC is addressed in Section 2.1.2.1; groundwater is also discussed in Section 6.0 and Attachment E1 (Table E1-1). Measured levels of contamination in soil are discussed in Section 2.1.2.2 and presented in Attachment E1 (Table E1-2).

2.1.2.1 Groundwater Contamination

Concentrations of cadmium, copper, lead, and zinc detected during groundwater monitoring from 1992 to 1998 are presented in Attachment E1. Analytical results indicate that zinc, copper, and lead were detected in groundwater from CPC at concentrations up to 2,900,000 micrograms per liter (µg/L), 470 µg/L, and 510 µg/L, respectively (CWC 1999a). The highest metal concentrations were detected in groundwater wells V4R and M3R, located adjacent to the former surface impoundment (Figure 48). ES reports that a perched groundwater zone, consisting of 1 to 2 feet of fine sand underlain by several feet of saturated sandy or clayey silt, is present at a depth of approximately 30 feet below grade at CPC (ES 1987). This zone may be in hydraulic communication with Nichols Creek. The direction of

groundwater flow in the perched zone is westerly, toward Nichols Creek; the direction of groundwater flow in the lower sand zone was estimated to be northwesterly, toward the Litigation Area (ES 1987). Groundwater contamination detected at CPC is also addressed in Section 7.0.

2.1.2.2 Soil Contamination

Concentrations of copper, lead, and zinc detected in subsurface soil collected during groundwater monitoring well construction in 1987 are presented in Table E1-2 (ES 1987); sampling locations are shown on Figure 48. Additional surface soil samples were collected at 1, 2, and 3 feet below the surface impoundment in 1990; concentrations of cadmium (up to 35 milligrams per kilogram [mg/kg]), copper (up to 1,100 mg/kg), lead (up to 540 mg/kg), and zinc (up to 49,000 mg/kg), and were elevated, and are presented in Attachment E1 (The Mark Group 1990).

Soil Stockpile

A 12,500-cubic-yard stockpile is currently located at the CPC facility. The stockpile resulted from a 1992 soil excavation that removed approximately 14,000 cubic yards of soil contaminated with cadmium, copper, lead, and zinc from the southern portion of the property; of the 14,000 cubic yards removed, 1,500 cubic yards was moved off site for treatment in 1994 (Geomatrix 1999b). In response to an order issued by RWQCB in 1998 (Geomatrix 1999b), soil sampling for metals and leachable metals (using EPA synthetic precipitation leachate potential [SPLP] methods and waste extraction tests [WET]) was conducted in 1999 on the 12,500-cubic-yard soil stockpile that remains on the southern portion of the property. Concentrations of cadmium, copper, lead, and zinc detected in the samples are presented in the table below.

Sample Type	Cadmium	Copper	Lead	Zinc
Soil (mg/kg)	2.4 to 24.0	33 to 620	220 to 3,800	3,400 to 33,000
TTLC (mg/kg)	100	2,500	1,000	5,000
SPLP Metals (µg/L)	<5 to 250	NA	<3 to 330	3,200 to 49,000
WET Metals (µg/L)	250 to 4,000	1,600 –to 64,000	16,000 to 888,000	17,000 –to 1,500,000
STLC Limits (µg/L)	1,000	25,000	5,000	250,000

Notes: From Geomatrix 1999b

µg/L Microgram per liter
mg/kg Milligram per liter
STLC Soluble threshold limit concentration
TTLC Total threshold limit concentrations

2.1.3 Regulatory History and Previous Environmental Investigations

The regulatory history and previous environmental investigation for CPC are summarized in the following paragraphs.

CPC has been under regulatory scrutiny since 1969, when a criminal complaint was filed for illegal discharge of hazardous waste into waterways (DHS 1980). As a result of the conviction, CPC paid a $200 fine, removed tailing piles, enlarged drainage sumps, and improved storage facilities. RWQCB filed a second complaint in 1970 when water samples collected from Nichols Creek were shown to be toxic to fish. As a result of this complaint, on-site disposal of hazardous waste was eliminated in 1973.

Samples collected by the California Department of Fish and Game (CDFG) in 1975 indicated high levels of copper and zinc and elevated levels of cadmium and lead at the site (DHS 1980). In response to this finding, zinc-contaminated soil located north and south of the site was removed, the area between the northern plant boundary and the railroad tracks was paved, and runoff was pumped to a new holding pond. In 1978, RWQCB granted CPC a hazardous waste permit; in the permit, the RWQCB ordered the construction of the current impoundment. During 1980, RWQCB issued Order No. 80-38 stating that a 1.4-million-gallon pond be constructed at the site to collect surface water runoff. RWQCB samples collected from Nichols Creek in 1982 showed elevated sediment concentrations of copper (ranging up to 260 parts per million [ppm]) and zinc (ranging up to 73,000 ppm) (RWQCB 1982). A groundwater monitoring program was initiated by CPC in 1983, at the request of RWQCB (GTI 1992).

In 1986, RWQCB requested that CPC prepare a hydrogeologic assessment report (HAR) and close or retrofit the impoundment; CPC submitted the HAR in 1987 (ES 1987). The HAR reported that elevated concentrations of zinc were present in soil and groundwater. RWQCB subsequently directed CPC to close the impoundment (GTI 1992). In 1990, a report was submitted on the vertical extent of metals-containing soils beneath the surface impoundment (The Mark Group 1990). In February 1991, a closure plan for the surface impoundment was submitted (CPC 1991); the plan was deemed deficient by the regulatory agencies and a revised surface impoundment closure plan was submitted in 1992 (GTI 1992).

In November 1996, a surface impoundment closure report was submitted by CPC; the report was approved by RWQCB in 1997 (RWQCB 1997).

In May 1998, CPC filed Chapter 11 bankruptcy; CPC ceased operations on March 6, 1999 (CWC 2000). In June 1999, DTSC withdrew CPC's standardized hazardous waste facility permit, and required that

CPC submit a revised closure plan no later than July 2, 1999, to close the facility (DTSC 1999b). In October 1999, DTSC issued a summary of violations for CPC (CWC 1999b).

In November 1999, DTSC requested immediate corrective action measures for CPC, stating that "significant concern for off-site migration of contaminants" exists based on a site inspection on September 24, 1999 (DTSC 1999b). During the site inspection, DTSC observed the following:

- Three open-top zinc sulfate product solution tanks filled to capacity. According to DTSC, "this material presents a serious threat of release and concern due to potentially high concentrations of metals. Immediate steps need to be taken to fully cover the tanks to prevent overflow during the winter rains and secure the contents from unauthorized release with valve locks."

- Four tanks containing unknown quantities of liquid hazardous material, hazardous wastes, or their residues, including one 6,000-gallon and one 1,600-gallon capacity tank containing sulfuric acid, one 1,300-gallon capacity tank containing bleach, and one 4,100-gallon capacity tank containing caustic soda. According to DTSC, these materials present a corrosive hazard and potential environmental and human health hazard if released.

- Numerous sumps and pits that may be interconnected; contents are unknown.

- Severe mineral crusting and discoloration of soil in the northwestern corner of CPC where process runoff and rainwater were collected (DTSC 1999b).

Additional areas of concern (AOC) noted during the 1999 site visit are presented in the table below.

Area	Hazardous Materials or Waste of Concern
Upper Warehouse	Two drums with residual oil
	One drum with zinc dust
Zinc Slurry System and Recovery System	One drum vinyl ester resin
	One 5-gallon can of oil
	One drum of soda ash
Lower Warehouse	Nine drums of Petrolite steel wax
	Three drums of Crystal White steel oil
	Eleven 25-kilogram pales of potassium permanganate
	About 130 bags of soda ash
	Two 10-gallon buckets of sodium chlorate
	One bag of citric acid
	About eight bags of wetting agent (Morwet D425)
	About 60 super sacks of zinc sulfate product
	About six super sacks of zinc ashes from Armor Sales Corp.

Area	Hazardous Materials or Waste of Concern
Boiler Room	Four 5-gallon cans of oil
	Four drums of boiler water treatment chemicals
	Flammable location with about 15 gallons of points and epoxides
	Five acetylene tanks

In February 2000, CPC submitted a proposal to DTSC to (1) collect and remove waste material from the site, (2) prepare a groundwater closure letter, and (2) prepare a final report documenting the removal of waste material (DTSC 2000a). DTSC found the interim corrective action measures to be inadequate, and stated "there is a high probability of releases from the sumps and pits which can endanger human health and the environment" (DTSC 2000a). DTSC also asserted that the CPC property contains:

- More than 16 collection sumps and pits, most of which were full or overflowing.
- Hazardous and potentially hazardous waste may remain in tanks at the site, including (1) three tanks containing from 10,000 to 15, 0000 gallons of zinc sulfate solution; (2) product tanks formerly used to store bleach, hydrogen chloride, sulfuric acid, and other caustic material.
- A significant quantity of metals-bearing powders on the floors, in and on the equipment, and in containers.
- A hazardous waste pile of 12,500 cubic yards of lead- and zinc-contaminated soil (DTSC 2000a).

In March 2000, CPC converted from Chapter 11 to Chapter 7 bankruptcy (CWC 2000). In July 2000, DTSC recommended transferring the site from the Standardized Permits and Corrective Branch to the Site Mitigation Branch (DTSC 2000b). No record of further environmental investigation of the property was found in the regulatory files.

2.1.4 Previous Remedial Actions

In 1975, CPC excavated some soil from the area adjoining the railroad tracks and in the open field south of the plant. In addition, CPC paved some working areas and installed a retaining wall and a sump drainage system into a new holding pond (DHS 1980).

CPC removed site sludge in 1997 and began closure of the surface impoundments, including:

- Removal of existing impoundment liquids (storm water)
- Compaction of left–in-place wastes and impacted native soil
- Back fill and compaction of the impoundment
- Placement of a semi-impermeable clay mat, a 40-milliliter high-density polyethylene liner, a geodrain, a polyvinyl chloride drainpipe, geotextile fabric, and top soil cover, with appropriate slopes to channel storm water
- Groundwater extraction and semiannual groundwater monitoring of the lower and perched aquifer zone (RWQCB 1997)

2.1.5 Potential Contaminant Migration Pathways to Navy Property

According to DTSC, a "high potential for off-site migration" exists from hazardous materials that remain at the CPC site (DTSC 2000a, 2000b). Because CPC is situated upslope from the Litigation Area, it is likely that the Litigation Area receives surface runoff and erosional material from the site that may contain high levels of cadmium, copper, cadmium, lead, and zinc. Based on a review of groundwater monitoring reports, the direction of groundwater flow is northwesterly, toward the Litigation Area property, and groundwater under CPC is contaminated with metals at high concentrations (ES 1987). Potential interaction of contaminated groundwater from CPC and surface water in Nichols Creek should be further evaluated.

Based on the review of information presented above, it is likely that CPC is a continuing source of chemical contamination to the Litigation Area. It is recommended that the Navy and the regulatory and trustee agencies consider the CPC property as an ongoing potential source of contamination when considering any additional monitoring or remedial actions for the Litigation Area.

2.2 GENERAL CHEMICAL CORPORATION (FORMERLY ALLIED SIGNAL)

The following sections summarize information collected during the review of regulatory and trustee agencies' files on GCC. Current DTSC files on this facility, combined with records for GCC's predecessor, Allied Corporation Bay Point Works, are extensive. TtEMI reviewed only the more current portions of these records.

2.2.1 Facility Background

GCC Bay Point Works is located at 501 Nichols Road, Pittsburg, California, on property that was originally developed in 1905 by Nichols Chemical Company. In 1920, Nichols Chemical Company

merged with several other companies to form Allied Chemical Corporation. From 1920 to 1981, the company underwent several name changes, the last of which was Allied Signal. In 1986, Allied Signal sold the major manufacturing portion of the facility (26 acres of the 140-acre property) to GCC. In 1998, Allied Signal sold the polymer resins manufacturing plant to Rhone Poulenc, who in 1995 sold it to Polypure, Inc (Section 2.4). During the late 1990s (the specific date is not known), Honeywell merged with Allied Signal; since that time, the former Allied Signal property has been owned and managed by Honeywell. The numerous ownership changes of the property are summarized in Attachment E2.

Facility operations under Allied Signal included the production of sulfuric acid, nitric acid, HF acid, alum (aluminum sulfate), and lead arsenate and the repackaging of pesticides. In the mid-1960s, chemically pure (CP) processes were added to produce high purity acids for the electronics industry. A list of chemical products manufactured at the Allied Signal facility is presented in Attachment E2. GCC has continued to produce CP acids and etchants (including polymer resins, sulfuric acid, nitric acid, HF acid, and chromic acid and alum), ammonia, aluminum acetic acid, ammonium fluoride, oleum, and bauxide since it purchased the manufacturing plant in 1986 from Allied Signal. Allied Signal shut down and dismantled the sulfuric and hydrofluoric acid plants in 1981 and 1984, respectively (Montgomery Watson 2000a). In addition, GCC has been packaging solvents at the facility since 1986, including 2-propanol, methanol, N-butyl acetate, acetone, and methyl ethyl ketone. The GCC facility occupies approximately 26 acres, including chemical plants, a warehouse, support service buildings, a permitted hazardous waste storage system that was upgraded in 1995, and a wastewater effluent lagoon (International Technology Corporation [IT] 1999a; Community Profile 1999). A timeline of events at GCC is presented in Attachment E2.

2.2.2 Contamination

On-site disposal of hazardous wastes was apparently the primary waste management method used during most of the plant's operating history (EPA 1984). Releases of metals (arsenic, aluminum, chromium, lead, and sodium), ammonia, fluoride, nitrite, nitrate, sulfate, sulfite, orthophosphate, and volatile organic compounds (VOC) to soil and groundwater have been identified at GCC (Community Profile 1999). The following discussion focuses on chemicals of concern in the portion of the facility that is adjacent to the Litigation Area, the major manufacturing portion of the facility (known as Area of Concern 1 [AOC1]).

The chemicals of potential concern (COPC) identified in the conceptual site model for AOC1 at GCC are primarily metals, including aluminum, arsenic, lead, chromium, mercury, and selenium. Other COPCs are decreased pH; low concentrations of solvents; benzene, toluene, ethylbenzene, and xylenes (BTEX);

total petroleum hydrocarbons as gasoline (TPH-g), pesticides and herbicides (including carbon disulfide, dichlorodiphenyltrichloroethane, and endosulfan II), and polychlorinated biphenyls (PCB) (Montgomery Watson 2000a). Concentrations of these COPCs in groundwater and soil are discussed below.

2.2.2.1 Groundwater Contamination

Maximum chemical concentrations in filtered groundwater samples collected at AOC1 are presented in Attachment E1. Sample locations are presented on Figure 48. Concentrations of metals and pH are the primary chemicals of concern. Elevated concentrations of aluminum (2,400,000 µg/L), arsenic (40,000 µg/L), chromium (270 µg/L), lead (5.3 µg/L), mercury (2.5 µg/L), and selenium (140 µg/L) were reported (Attachment E1) (IT 1999a). Aluminum and arsenic are the two chemicals that most often exceeded background levels (IT 1999a). Groundwater pH ranged from 3.2 standard units at well MW-S5 to 7.6 standard units at well MW-S4. Groundwater contamination detected at GCC is also addressed in Section 7.0.

Low levels of TPH-g and BTEX were detected in groundwater samples from the northern portion of AOC1, adjacent to the Honeywell waste lagoon (IT 1999a) (Figure 48).

2.2.2.2 Soil Contamination

The primary metals of concern in soil for AOC1 at GCC are aluminum, arsenic, chromium, lead, mercury, and selenium. One localized hot spot is the northwestern portion of the property, adjacent to the Honeywell waste lagoon and the Litigation Area (IT 1999a). Arsenic and lead are the compounds that most frequently exceeded background levels. Maximum chemical concentrations in soil at AOC1 are presented in Attachment E1.

A review of TPH-g and BTEX data indicates that low concentrations of these chemicals are present in soil around a closed underground storage tank (UST) near the northwestern corner of the Bay Point Works Facility (IT 1999a). A review of pesticide and PCB data shows that presence of these chemicals are primarily adjacent to the west and north sides of Polypure, Inc. (IT 1999a) (Figure 48). Soil pH data indicated that GCC soil has been affected by both acidic and caustic sources (IT 1999a). Soil pH ranged from 2.6 for the soil sample collected at AOC1-19 at 1.5 feet below ground surface (bgs) to 11.7 for the soil sample SMO8-01 collected at 1.0 foot bgs (IT 1999a). Extreme soil pH (both low and high) significantly affects the bioavailability of metals in soil.

2.2.3 Regulatory History and Previous Environmental Investigations

The following paragraphs summarize GCC's regulatory history from 1990 through today. Additional information for the years before 1990 is summarized in the timeline (Attachment E2).

A Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) for GCC was initiated by DTSC in 1991 and was issued in 1992. The RFA resulted in inclusion of RCRA corrective action requirements as part of the hazardous waste facility permit renewal issued in 1994. The RFA report assigned 1 hazardous waste management unit (HWMU) and 14 solid waste management units (SWMU) for further investigation. The RCRA facility investigation (RFI) report was completed in 1995; the report indicated that (1) releases occurred from 1 HWMU and 11 SWMUs that were investigated, and (2) soil and groundwater had been impacted by the releases (IT 1999a). The RFI report concluded that additional field investigation was needed at the site. The RFI report was approved by DTSC in December 1995.

From 1996 to 1997, negotiations for a corrective measure study (CMS) occurred. GCC prepared a CMS in 1999, which included the following:

- Investigations of soil and groundwater
- Air sampling and hydrogeologic studies (including a tidal study) to evaluate potential contaminant migration pathways
- A geochemical evaluation, including inorganic chemistry analyses and laboratory batch contact tests, to evaluate potential contaminant migration pathways through geochemical pathways

In February 1999, DTSC submitted a closure plan for the hazardous waste storage tank and the ancillary collection sumps at GCC; the expected year of closure for both systems is 2025 (DTSC 1999a). DTSC issued a Notice of Deficiency for the CMS task 1 activities report in August 1999 (DTSC 1999c).

GCC is currently in the process of filling data gaps identified in the CMS task 1 report. These data gaps include (1) investigations on background concentrations of metals in groundwater, (2) an assessment of the vertical and lateral extent of impact, (3) an investigation of a potential air transport pathway, (4) an investigation of the effects of the Allied Signal dike system on groundwater flow and tidal influence, (5) confirmation of metals attenuation in groundwater, (6) a human and ecological risk assessment, and (7) establishment of media cleanup standards (Montgomery Watson 2000a; DTSC 1999c; IT 1999a). In March 2000, CPC issued a draft technical memorandum to establish background metal concentrations in

soil and groundwater and a draft technical memorandum that evaluated the fate and transport of metals in groundwater (Montgomery Watson 2000b, 2000c).

2.2.4 Previous Remedial Actions

No evidence of remedial action at GCC was found during the file reviews.

2.2.5 Potential Contaminant Migration Pathways to Navy Property

The potential contaminant pathways for GCC contamination to migrate to the Litigation Area are through groundwater and surface runoff. These two pathways are discussed below.

2.2.5.1 Groundwater

IT reported that groundwater flows in a northwesterly direction on the northwestern portion of AOC1, in an easterly (or even southeasterly) direction in the southeast portion of AOC1, and a northerly direction in the north-central portion of AOC1 (IT 1999b). According to DTSC, groundwater along the western property boundary moves in a northwesterly direction towards the wetlands in the Litigation Area (DTSC 1999c).

A RCRA CMS reported that no significant hydraulic communication exists between shallow groundwater beneath the Bay Point Works Facility and the Litigation Area wetlands (IT 1999a). The report also concluded that although groundwater on the western edge of the Bay Point Works Facility is shallow or at ground surface, the groundwater gradient toward the west is very flat and seepage velocities through the saturated sediments are very low, on the order of 0.5 to 3.0 feet per 100 years (IT 1999a). However, DTSC concluded that the monitoring wells along the northern, eastern, and western boundaries of AOC1 have significant dissolved metal concentrations, indicating that the plumes originating from the GCC facility have probably moved beyond their boundaries. According to the DTSC Notice of Deficiency for the CMS task 1 report, metal concentrations along the northern boundary of AOC1 are of greatest concern (DTSC 1999c). DTSC also claimed that groundwater along the northern boundary of AOC1 has significant organic concentrations (DTSC 1999c). The Navy will review available information about groundwater contamination at GCC to assess its potential impact on groundwater in the Litigation Area.

2.2.5.2 Surface Runoff and Soil Erosion

It is likely that the Litigation Area receives some surface runoff and erosional material from adjacent portions of GCC that may contain high concentrations of aluminum, arsenic, chromium, lead, mercury,

and selenium; however, this migration pathway is minimized by the fact that the facility is entirely paved and a raised berm is between the GCC facility and the Litigation Area. DTSC concluded that concentrations of aluminum, arsenic, lead, mercury, and selenium as observed in borings AOC1-1 and AOC1-10 are elevated and suggest that significant metal contamination may exist off site (DTSC 1999c). Based on the review of information presented above, it is possible that GCC is a continuing source of chemical contamination to soils in the Litigation Area. It is recommended that the Navy and the regulatory and trustee agencies consider GCC as an ongoing potential source of contamination when considering further monitoring or remedial action for soils in the Litigation Area.

2.3 HONEYWELL INTERNATIONAL

The following section summarizes the information collected about the Honeywell property during the review of GCC agency files. No Honeywell property file reviews were conducted, because they were not a known property owner at the time of the file review. Therefore, environmental contamination information for the Honeywell property is incomplete.

2.3.1 Facility Background

Allied Signal and Honeywell Incorporated merged in 1999 to form Honeywell International. Honeywell owns property immediately north and east of the GCC Bay Point facility (Figure 3). This property includes a former alum mud pond, an inactive solid waste disposal area, a former gypsum stockpile area, and a former HF acid plant (CH2MHill 2000). The former alum mud pond and inactive solid waste disposal area are the two sites that are adjacent to the Litigation Area.

2.3.2 Contamination

Evidence exists that chemical contamination occurred in both the former alum mud pond and the inactive solid waste disposal area based on previous environmental investigations; however, no reports were retrieved during the file review that included soil or groundwater concentrations. The former alum mud pond is separated from the Litigation Area wetlands by an earthen berm. Alum muds from bauxite extraction were placed in this area from about the early 1900s to the late 1980s (CH2MHill 1998). The area contains ponded water during the rainy season; shorebirds, egrets, and herons have been observed in the alum ponds by Navy contractors. Potential chemicals of concern under investigation by Honeywell include metals, fluoride, and low pH (CH2MHill 1998). Soil pH ranges in the former alum mud pond reportedly ranged from 3.03 to 7.2 (Montgomery Watson 2000a).

The inactive solid waste disposal area is also bounded by an earthen berm. This area reportedly contains iron pyrite, coke, brick, excelsior (cellulose packing material), and vanadium-containing catalyst. COPCs include metals, semivolatile organic compounds (SVOC) (such as polycyclic aromatic hydrocarbons (PAH) from coke), low pH, fluoride, and organochlorine pesticides (CH2MHill 1998). Detections of organics (pesticides and PAHs) occurred in the inactive waste disposal area (Montgomery Watson 2000a). Soil pH in the inactive solid waste disposal area reportedly ranged from 4.45 to 7.58 (Montgomery Watson 2000a).

2.3.3 Regulatory History and Previous Environmental Investigations

In 1976, RWQCB ordered Allied Signal to address low pH discharges from the former alum mud pond to the bay. In response to this order, Allied Signal constructed the dike system around the property to restrict surface and groundwater flow to the bay. The response action also included neutralization of materials within the diked area. In 1995, Allied Signal performed excavation and off-site management of metals-affected soil from the western portion of the facility in cooperation with the Navy.

In August 1998, Honeywell initiated site investigation activities in accordance with a voluntary cleanup agreement with the DTSC (CH2MHill 2000). Site investigation activities to date have included a draft preliminary endangerment assessment (PEA) work plan, a draft PEA sampling and analysis plan (SAP), a draft PEA SAP addendum, a phase 1 data report, and a phase 2 data field sampling plan (FSP) (CH2MHill 2000; Montgomery Watson 2000e). The Phase 2 field investigation includes soil sampling, installation of piezometers, collection of surface water samples, installation of staff gauges, and quarterly groundwater monitoring (CH2MHill 2000).

2.3.4 Previous Remedial Actions

In 1977, Allied Chemical Corporation scraped approximately 7,800 cubic yards of contaminated soils from the north side of the RASS 1 active remediation area, and applied agricultural lime to about 8 acres on the south side of RASS 1 active remediation area (Ecology and Environment, Inc. 1983). Additional remedial actions of the soils on the western portion of the facility were conducted at the same time as the Litigation Area remedial action in RASS 1 (in 1995). Remedial actions included the excavation and off-site management of metals-affected sediment and soil and wetlands restoration.

2.3.5 Potential Contaminant Pathway to Navy Property

According to the conceptual site model for the former alum mud pond, potential contaminant migration pathway exists to the Litigation Area through groundwater migration and food-chain transfer (CH2MHill

1998). According to the conceptual site model for the inactive solid waste disposal area, potential contaminant pathways to the Litigation Area include groundwater migration, wind-blown dust, and food-chain transfer. GCC documents about the current Honeywell North property that were reviewed did not indicate groundwater flow directions. However, groundwater flow directions at properties north and west of the Honeywell North property are to the west or northwest toward the Litigation Area marsh; therefore, it is likely that groundwater from the alum ponds flows toward the Litigation Area marsh. Groundwater flow rates are not known, but are likely to be very slow if the subsurface lithology at the Honeywell property matches the lithology in the Litigation Area immediately west of the alum pond.

2.4 POLYPURE, INC.

Polypure, Inc. produces and distributes two families of water treatment polymers. The two types produced at the plant are known as "Mannich" polymer (Mannich derivative of polyacrylamide) and melamine formaldehyde. Polypure's Bay Point facility was originally a pilot facility designed and built to develop improved methods of manufacturing water treatment polymers. Before 1985, the plant did not use a separate reactor to accomplish the initial polymerization of carylamide monomer. Allied Signal was the previous owner of Polypure Inc. property; they previously manufactured lead arsenate-based pesticides at the site. No regulatory agency files for Polypure Inc. were available for review; therefore, the potential for contaminant migration from this facility is unknown.

2.5 GWF POWER SYSTEMS COMPANY, INC.

GWF, an electricity generating facility, is located at 555 Nichols Road, across the road from CPC. To generate electrical power, GWF burns petroleum coke (a byproduct of local crude oil refining operations), which is supplemented by coal and oil. The former town of Nichols, where many Allied Signal employees used to live, was located in the area now occupied by GWF and to the north toward GCC. The information available for review in the regulatory agency files regarding this facility is summarized below.

- Elevated lead in soil was found on the site before the establishment of GWF. Detections appear to have been limited and range from 4 to 52 mg/kg (Harding Lawson Associates [HLA 1987]).
- GWF discharges wastewater to a deepwater outfall to Suisun Bay.

Lead in soil is the only known contaminant at the site with a potential for migration to Navy property. HLA (1987) concluded that elevated lead concentrations could be attributable to fill material with high

lead concentrations or lead from CPC, located across Nichols Road. The site is currently paved with concrete, so the potential for lead to migrate from GWF to the Litigation Area is considered low.

2.6 RAILROAD COMPANIES

Several railways bisect the Litigation Area; historic spills and ongoing activities from these railways may act as continuing off-site sources of contaminants to the Litigation Area. Three railroad companies, including SPTC, ATSF, and SNR, own right-of-ways in the Litigation Area; the right-of-ways include 50 feet on either side of the tracks (Figure 3).

2.6.1 Background

The railroad tracks have been present at the site for many decades; in fact, the SPTC track between RASS 1 and RASS 3 is the original transcontinental railroad.

2.6.2 Contamination

All three of these railroad companies had right-of-ways that were affected by historic chemical spills emanating from neighboring chemical companies. The SNR and ATSF tracks lay on the southern side of RASS 3, and the rights-of-ways were affected by chemical spills from the CPC near Nichols Creek. The SPTC track lies between RASS 3 and RASSs 1 and 2, and the right-of-way on the southern side was affected by chemical spills from the CPC that migrated down Nichols Creek. The right-of-way on the northern side was affected by chemicals from the GCC site and former industrial activities in RASS 2. ATSF owns an area beyond the 50-foot right-of-way inside the RASS 2 boundary.

2.6.3 Regulatory History and Previous Environmental Investigations

No regulatory agency files were reviewed for the railroad properties; therefore, the regulatory history and previous environmental investigations for the railroad companies are unknown.

2.6.4 Previous Remedial Actions

In the ROD, the Navy stated that the remedial alternatives should also be implemented on the off-site parcels owned by the railroads to prevent recontamination of the Navy's property (Navy 1989). In Consent Decrees between the United States and the railroads, the railroads agreed to undertake appropriate remedial action to reduce soil contamination and prevent recontamination of the Navy's property. The railroad defendants agreed to remediate contaminated portions of the three railroad rights-of-way to below total threshold limit concentrations and soluble threshold limit concentration criteria.

The cleanup of some of the neighboring railroad property has yet to be completed. As presented on Figure 3, an ongoing remediation by ATSF occurs in the southern portion of RASS 2 near the railroad track. This area has four deep surface impoundments where soil was removed many years ago but has yet to be replaced or regraded. These surface impoundments fill with metals-contaminated water during the winter; RWQCB has conducted some sampling in these impoundments. The Navy has collected soil and sediment samples at numerous locations on the edge of the railroad right–of-way; many of these samples consistently show elevated concentrations of zinc and other metals.

2.6.5 Potential for Contaminant Migration to Navy Property

Historic and ongoing operational activities conducted by the railroad companies may still be contributing contaminants to the right-of-ways that may migrate to the Litigation Area. Engine operations, track maintenance operations, spraying of herbicides along track, creosote-soaked railroad ties, and accidental or illegal dumping along tracks could all have contributed to some contamination in the Litigation Area; some of these sources may be ongoing. The agencies have asked the Navy to sample for PCBs on the Navy's property along the railroad right-of-way in RASS 3 because PCBs have been detected in this area at concentrations up to 1.5 ppm, and ongoing engine operations are known to release PCBs.

3.0 EROSION AND MOBILIZATION OF CONTAMINATED SOILS THROUGH SURFACE WATER IN NICHOLS CREEK

Nichols Creek is a shallow ephemeral stream that drains a small watershed in the Los Medanos Hills, flows north along the western boundary of the Chemical and Pigment property, and terminates in the RASS 3 pond, where water from the creek is temporarily impounded (Figure 3). The RASS 3 pond is tidally influenced, and ultimately discharges to the Lost Slough. Water from the RASS 3 pond travels underneath the railroad trestle when the tidal stage decreases and allows drainage of the pond. Water flows in the lowermost reaches of Nichols Creek for about 6 months per year, during and just after the wet season.

Soils along the bed of Nichols Creek were removed from the site during the remediation of RASS 3 from May 1993 through July 1994. The remediated area was then recontoured, so that Nichols Creek flows along the same approximate creek bed that it flowed in before remediation. Some cutting was performed to provide a defined flow channel for Nichols Creek. Visual observations during ongoing monitoring of the Litigation Area indicate that soils along Nichols Creek have eroded and may still be eroding, creating the potential to mobilize the remaining contaminated soils to the marsh. Areas of soil erosion were mapped during a site survey on October 6, 2000, to determine whether areas of active soil erosion

coincide with areas of known soil contamination. A sediment flux study conducted in 1998 to address concerns about contaminant migration and the mapping effort conducted in October 2000 are discussed in the following sections.

3.1 PREVIOUS INVESTIGATION

A sediment flux study was conducted in 1998 to quantify the volume of sediments transported through Nichols Creek. Flow in Nichols Creek and suspended sediment concentrations were measured at four locations along the creek during base flow conditions and immediately after a significant storm in March 1998. Sediment load was quantified by multiplying suspended solids concentrations by flow volume. The year 4 monitoring report (TtEMI 1999) contains a detailed discussion of the sediment flux study.

The average base flow rate at the four locations in Nichols Creek was 0.9 liter per sec [L/sec] (20,700 gallons per day [gpd]), and the average storm flow rate at the four locations was 2 L/sec (45,900 gpd). Average total suspended solids (TSS) concentrations of 25 milligrams per liter (mg/L) and 90 mg/L were measured for the base flow and storm events. Because the flow velocity after the storm event was much greater, almost 10 times the quantity of suspended solids were transported through Nichols Creek after the storm than before. As a result, solids transport through Nichols Creek appears to be a piecemeal process, with a low background rate of solids transport punctuated by periodic pulses of higher solids transport following storm events. As a rough upper limit of the total volume of sediments transported through Nichols Creek annually, the maximum daily sediment load was multiplied by 8 months to derive an annual sediment load for Nichols Creek. Based on the measured TSS concentrations, flow rates, and the assumption that Nichols Creek flows for 8 months of the year, a total of approximately 3,700 kilograms of sediment per year, or approximately 1.4 cubic meters of sediments, transported suspended solids through Nichols Creek was estimated.

Suspended solids concentrations in water flowing from the RASS 3 pond into the marsh were also measured during the sediment flux study. The RASS 3 pond is tidally influenced, and water exits the pond only during low tidal stages. TSS concentrations in water exiting the RASS 3 pond under the railroad trestle were significantly lower (3 to 12 mg/L) than the water flowing into the pond through Nichols Creek, indicating that the pond acts as a settling basin that traps a significant portion of sediments that are transported through Nichols Creek. The assumption that the pond traps sediments is consistent with observations that water depths in the pond have gradually decreased since the pond was created in 1993 to 1994. The RASS 3 pond is currently vegetated with dense stands of cattails and other plants that help to reduce flow rates and increase the sediment trapping ability of the pond.

3.2 NICHOLS CREEK SEDIMENT EROSION MAPPING

The objective of mapping visible erosion along Nichols Creek was to define areas that are currently eroding and to compare these erosional areas with known areas of soil contamination to determine whether contaminated soils are eroding and being mobilized downstream by Nichols Creek. The erosional areas were mapped on October 6, 2000, by walking the entire length of Nichols Creek on Navy property from south to north and by noting locations of erosional areas using a hand-held GPS. Other features of Nichols Creek were also noted, including vegetation, whether the channel of the creek was incised or not, and whether water was flowing in the creek bed.

The results of the Nichols Creek erosion mapping are illustrated on Figure 49. Locations shown on the figure should be considered approximate. Mapping established the locations of two major erosional areas south and north of where Nichols Creek passes beneath the railroad tracks near the CPC property (erosional areas 1 and 2 on Figure 49). These areas are almost entirely within the ATSF and SNR railroad right-of-ways. The area between the two sets of railroad tracks showed little evidence of erosion. The approximate dimensions of the major erosional areas were measured in the field with a measuring tape. Erosional area 1, south of the railroad tracks, is approximately 56 feet long from east to west, 25 feet wide from north to south, and 8 to 10 feet deep. Erosional area 2, north of the railroad tracks, is a teardrop shaped depression centered on the culverts that pass beneath the railroad tracks, with dimensions of approximately 40 feet east to west at the base, 36 feet from north to south, and a depth of 8 to 10 feet. Significant amounts of soil (200 to 300 cubic yards) have been lost from each of these erosional areas. Soil samples from nearby locations exhibited zinc concentrations greater than four times the effects-range median (ER-M), indicating that erosion in this area clearly has the potential to mobilize and transport contaminated soil downstream through Nichols Creek.

Mapping revealed that, in addition to these major erosional areas near the railroad tracks, areas of active soil erosion occur that extend along the creek bed for approximately 500 feet north of the railroad tracks. A continuous near-vertical escarpment on the western bank of Nichols Creek extends about 150 feet northward from erosional area 2, signifying active erosion of this area. Soils immediately west of this escarpment are contaminated with zinc concentrations equal to or greater than four times the ER-M.

North of this continuous escarpment, discontinuous escarpments and localized erosional depressions in the creek bed are present at several locations. The most significant of these locations is a 12-foot-wide erosional depression, which is approximately 5 feet deep (Figure 49). In-place visqueen plastic sheeting is visible at this location, and the creek bed has eroded soils beneath the visqueen. Although the origin of

the visqueen sheeting is not definitively known, it is likely that it was placed at the bottom of an excavation and then buried. Erosion of soils beneath the sheeting suggests that native materials are eroding. Slump blocks were observed at one location north of the 12-foot-wide erosional depression. Soils along this stretch of Nichols Creek where discontinuous escarpments, slumping, and erosional depressions were observed were contaminated with zinc at concentrations that did not exceed four times the ER-M.

North of the discontinuous erosional area, Nichols Creek turns to the west and the creek bed becomes less well defined and filled with dense stands of reeds. The incised creek bed is interrupted periodically by grassy swales, and begins to bifurcate and becomes a braided channel directly south of monitoring well 2AG09. Two isolated erosional pits with approximate diameters of 3 feet were observed just before the area where the channel becomes braided. No well-defined channel exists from the area due south of monitoring well 2AG09 to the RASS 3 pond. Soils along this stretch of Nichols Creek were generally contaminated with zinc or other metals at concentrations that did not exceed four times the ER-M. The area near the small erosional pits was contaminated with zinc at concentrations greater than four times the ER-M.

One surprising feature of the erosional mapping work was the observation that surface water was still flowing in the southern portion of Nichols Creek at the beginning of October 2000, when the erosional mapping was completed. Because the creek was mapped at the end of the dry season when surface water was least likely to be present in an ephemeral stream, some portions of Nichols Creek appear to flow for the entire year during some years. Flow was observed in Nichols Creek in the area south of the railroad tracks where the creek flows along the boundary of CPC and the area north, through (and apparently around or beneath) the culverts beneath the railroad tracks, and into erosional area 2. The creek bed becomes dry at the north end of erosional area 2.

The flow rate in Nichols Creek was very low, visually estimated to be on the order of one-tenth the flow rate observed during the sediment flux study conducted in 1998 (TtEMI 1999) when flow rates of 1 to 2 L/sec were measured. Nichols Creek appears to be a losing stream during the dry season, and surface water from Nichols Creek recharges groundwater in RASS 3. Groundwater recharge from Nichols Creek is a likely explanation for the groundwater high observed at monitoring well 3MG11 (Section 7.0).

3.3 DISCUSSION AND CONCLUSIONS

A sediment flux study conducted in 1998 estimated that 1.4 cubic meters of sediment are moved through Nichols Creek annually. The dimensions of the observed major erosional areas suggest that the annual

volume of eroded sediments in Nichols Creek has been much higher in the past or that 1.4 cubic meters of sediment per year underestimates the amount of annual sediment movement through Nichols Creek. The bulk of sediments eroded from the banks of Nichols Creek likely become trapped in the RASS 3 pond, which acts as a settling basin before discharging water to the marsh. The Nichols Creek erosion mapping established that several areas of the creek bed are actively eroding, as evidenced by vertical escarpments, slump blocks, and erosional depressions on the creek bed. The most intense erosion occurs in areas immediately south of the railroad tracks and in an area extending about 150 feet north of the tracks. The most actively eroding soils within this area of intensive erosion lie within the railroad right-of-ways that extend 50 feet on either side of the railroad tracks. These erosional areas gradually dissipated in the downstream direction, and the creek bed showed evidence of intermittent erosion for an additional 500 feet north. Soils adjacent to the active erosional areas are contaminated with zinc at concentrations greater than four times the ER-M, and the creek bed erosion obviously has potential to mobilize these contaminated soils downstream.

4.0 MOBILIZATION OF SOILS FROM THE MARSH SURFACE

Chemical spills from adjacent facilities in the 1950s, 1960s, and 1970s caused metals contamination to spread over the surface of the Litigation Area marsh, especially in the southeastern portion of the marsh. Areas affected by these spills are illustrated on Figures 5 and 6. The remedial action conducted in 1993 and 1994 removed soils from the most contaminated areas, but left some of the contaminated soils outside of the remediated areas in place. Areas where contaminated soils were removed are illustrated on Figure 12. Following remediation, the Navy conducted postremediation monitoring and several focused studies to assess whether the remaining metals-contaminated soils are mobile and are affecting water and sediment quality in uncontaminated portions of the marsh and in Suisun Bay. The distinction between soils and sediments in the Litigation Area is not clear-cut. In this section, the term “soil” refers to materials that are not typically inundated for most of the day, whereas the term “sediment” refers to materials that typically are inundated most of the day.

In an effort to obtain more detailed information about potential mobilization of contaminated soils from the marsh surface, the Navy conducted special studies, including long-term turbidity monitoring, a soil accretion study, and marsh surface metals profiling using X-ray fluorescence (XRF), to obtain more detailed information about the vertical distribution of metals in the marsh surface and sediments in the mosquito ditches and Lost Slough. The previous investigations and the metals profiling are described in detail in the following sections.

4.1 PREVIOUS INVESTIGATIONS

The Navy conducted two investigations in 1999 to assess sediment mobility in the marsh: long-term turbidity monitoring and a soil accretion study. These investigations are discussed in detail in the year 5 monitoring report (TtEMI 2000a) and are summarized below.

4.1.1 Long-term Turbidity Monitoring (January through April 1999)

The Navy conducted long-term turbidity monitoring to assess the net direction of sediment transport as suspended solids in the Litigation Area marsh. Turbidity is defined as the ability of a translucent material to scatter or absorb light rather than transmit it (American Public Health Association 1989), and is considered an indirect measure of suspended particles in water. The goal of the long-term turbidity monitoring was to assess sediment transport by recording changes in turbidity at the mouth of Lost Slough over many tidal cycles and winter rainfall events. Transport of sediments into the marsh would be expressed as turbidity asymmetry, where incoming tides have higher turbidity than outgoing tides. Turbidity at the mouth of Lost Slough was recorded with a submerged water quality sonde at 15-minute intervals from January 18 to April 20, 1999, for a total of approximately 8,000 separate turbidity measurements during 140 complete tidal cycles. The instrument was calibrated at the beginning of monitoring and at 2-week intervals during the monitoring period.

Figure 50 shows that turbidity of incoming tides typically exceeds the turbidity of outgoing tides by a significant margin, indicating that the net direction of sediment transport is from Suisun Bay into the Litigation Area marsh. Turbidity peaks typically corresponded with incoming tides, and turbidity typically dipped during outgoing tides. In a few cases, the reverse is true because turbidity of some outgoing tides exceeded that of incoming tides. Turbidity data were statistically evaluated, and the turbidity difference between incoming tides and outgoing tides was found to be statistically significant.

In situ turbidity measurements were compared with measurements of turbidity and TSS concentrations in grab water samples collected during instrument calibration at 2-week intervals during the monitoring period. Turbidity measurements of the grab samples were generally in agreement with measurements reported by the submersed sonde, although the grab samples were biased lower. This measurement bias can be attributed to differences in the analytical instruments used to measure turbidity.

Grab samples collected at 2-week intervals from incoming and outgoing tides were also analyzed for TSS. In contrast with the turbidity data, TSS concentrations in four of the five sets of samples were lower for incoming tides than for outgoing tides. Turbidity of incoming tides exceeded that of outgoing tides for

these same sample pairs, indicating that the smaller amount of suspended solids contained in incoming tides creates greater turbidity. This result suggests that the outgoing tides contain suspended materials that do not scatter light to the same extent as the suspended materials in the incoming tide. A likely explanation for this phenomenon is that outgoing tides contain high concentrations of organic material that does not scatter light to the same extent as inorganic material.

Export of suspended solid materials from tidal marshes is a phenomenon that has been commented on by other researchers. Settlemyre and Gardner (1977) and Ward (1981) noted that the two east coast marshes they studied were net exporters of suspended solids and that much of the exported material was organic. Settlemyre and Gardner (1977) also note that, although the marsh they examined is a net exporter of TSS, the marsh is a net importer of inorganic suspended solids. Based on these observations, net export of suspended solids from the Litigation Area marsh is not necessarily in conflict with accretion of inorganic soils such as silt and clay in the marsh; while organic suspended solids may be exported into Suisun Bay, inorganic suspended solids appear to be imported into the marsh.

4.1.2 Soil Accretion Study (1999)

As an additional effort to assess mobilization of contaminated soils and sediments from the marsh surface, the Navy measured soil accretion rates in 1999 at three locations in the southeastern corner of RASS 1, where high concentrations of metals are present at the marsh surface (R01SS091, R01SS264, and R01DH261). The age of marker horizons within the soil cores were identified using lead-210 (^{210}Pb) dating and palynological techniques, and the net accretion rates were determined by dividing the amount of soil that has accumulated above the soil horizon by the time elapsed since the horizon was deposited. These isotopic and palynological techniques are described in detail in the year 5 monitoring report (TtEMI 2000a).

The two soil dating methods used independent techniques to derive comparable accretion rates for the marsh soils. These methods show that the marsh has been accreting soils more or less continuously for the past 200 years. Estimated recent accretion rates vary from place to place on the marsh and vertically within a single sample core. Accretion rates for individual segments within a soil core ranging from 1.6 to 4.5 millimeters per year (mm/yr) were calculated. An average accretion rate for the entire marsh of 2.5 mm/yr is estimated, which corresponds to the accumulation of approximately 1 inch of soil every 10 years.

Lead isotope and palynological evidence independently establish that the marsh has accreted soils throughout the past 200 years and that more than 50 centimeters of soil have accumulated on the marsh

surface since European settlement of the San Francisco Area. Assuming an average soil accretion rate for the Litigation Area marsh of approximately 2.5 mm/yr, approximately 7.5 centimeters (3 inches) of soil have accumulated on the marsh surface since the chemical spills occurred in the 1960s and early 1970s.

Marsh accretion rates typically match the rate of relative sea level rise, so that the marsh surface elevation closely matches mean higher high water (Stevenson and others 1986). In San Francisco Bay, sea level is rising at a relative rate of approximately 1.5 mm/yr (Stevenson and others 1986). As a result, measured accretion rates in the Litigation Area marsh exceed the rate of sea level rise and suggest that the Litigation Area marsh is actively subsiding and accumulating soils at a greater rate than other marshes within San Francisco Bay, indicating possible regional subsidence of the Litigation Area marsh.

If the marsh surface were actively eroding rather than accreting, soil horizons with recent dates would be absent. However, the dating techniques demonstrated that recent horizons are present in the cores, indicating that the marsh surface is not eroding, thereby providing further evidence of marsh accretion.

4.2 METALS PROFILES FROM THE MARSH SURFACE

The dense vegetation that covers the Litigation Area marsh surface is expected to partially or completely immobilize contaminated soils, and accretion of new soil brought into the marsh through Lost Slough is expected to gradually bury the contaminated soils beneath cleaner soils. However, the vertical distribution of metals contamination in marsh surface soils was identified as a data gap that limits the assessment of contaminant deposition or vertical migration over time. In October 2000, the Navy addressed this data gap by collecting 10-inch-long soil cores from 13 locations across the marsh surface and vertically profiling these soil cores using energy dispersive XRF spectrometry. The purpose of creating profiles that illustrate the vertical distribution of metals was to establish whether (1) ongoing accretion of soils on the marsh surface is gradually burying the contaminated soil horizons under a steadily accumulating blanket of cleaner soils, and (2) metals are migrating vertically from the marsh surface. The 13 marsh surface soil core locations were selected to represent the most contaminated areas for a variety of metals based on existing monitoring data, and to achieve lateral coverage of the entire marsh (Figure 14).

4.2.1 Field Methods and Sample Preparation

Ten-inch marsh surface soil cores were collected from each location using a technique identical to that used to collect the cores for the palynological and ^{210}Pb dating described in Section 4.1.2. Soil core samples were obtained by manually digging 2-foot trenches on the marsh surface during low tide at each

location. Water was then removed from the mat of vegetation at the surface that accumulated in the trench; soils were shaved from one sidewall of the trench using a shovel and a serrated bread knife to expose a fresh, undisturbed soil column; and an intact soil core was extracted from the sidewall of each trench by sawing into the wall of the trench with a serrated bread knife. A rectangular block of soil was removed from the sidewall of the trenches and trimmed to a smaller dimension at the surface. The block was then securely wrapped in plastic wrap, labeled and marked with a prominent arrow indicating the top, frozen, and sent to the Space and Naval Warfare Systems Center (SSC) laboratory in San Diego, California, for analysis. At each soil core location, a 6-inch brass sample sleeve was pounded into an undisturbed portion of the marsh immediately adjacent to the 10-inch soil core to collect a sample for total organic carbon (TOC) analysis. The field sample collection and sample preparation techniques are described in detail in the five-year periodic review FSP (TtEMI 2000b).

Core samples were prepared for XRF analysis by dividing the 10-inch frozen cores into 1-inch segments. The top six 1-inch segments of the core and the bottom 1-inch segment were then separated from the core by sawing with a serrated bread knife. The top six segments were chosen to span the expected soil horizon that corresponds with the chemical spills shown on aerial photographs from the 1960s and 1970s; the bottom segment was intended as a measure of preindustrial conditions from approximately 1900. The segments were separated from the core while frozen to minimize rearrangement of soils contained in the cores. A clean serrated knife was used for each cut to minimize the potential for cross-contamination.

The outer portion of each segment was removed with a stainless steel spatula to ensure that the center portion of the slice was consistently used for analysis and to minimize the possibility that surface drag-down during sample collection or slicing of the soil cores had affected the vertical integrity of the sample. The inner portion of each segment was then placed in a foil cup and oven-dried overnight at 105 °C. The samples were dried to reduce the interference effects that moisture content of the soil might have on the XRF measurements. Each dried sample was ground and homogenized with a mortar and pestle and transferred to an XRF sample cup for analysis.

4.2.2 Laboratory Analysis

Samples were analyzed for arsenic, cadmium, copper, lead, selenium, and zinc by EPA Method 6200 using a QuanX XRF Spectrometer (Spectrace Instruments, Sunnyvale, California). This instrument contains an Rh-anode x-ray tube for primary generation of x-rays (4 to 50 kilovolts) and a thermoelectrically cooled, solid-state Silicon (Lithium) detector. The analytical instrument was calibrated using semistandardless fundamental parameters calibration. Five standard reference materials (National

Institute of Standards and Technology 2704, 2709, 2710, 2711 and CNRC PACS-1) were used for standardization.

4.2.3 Data Quality

Data quality of the XRF analyses was assessed using two methods. First, approximately 10 percent of the samples were analyzed for metals using both XRF and contract laboratory program (CLP) methods to verify that XRF results were representative of actual metals concentrations in the samples. Second, a standard reference material (PACS-1 marine sediment) was analyzed 30 different times during the course of this study to assess accuracy.

Duplicate samples analyzed using XRF and CLP methods are presented in Table 21 and are illustrated on Figure 51. A total of 30 confirmation samples were submitted to Severn-Trent Laboratories (STL) for analysis using standard CLP methods. These samples included complete sets of seven samples each from three soil cores and nine other randomly selected samples. Data presented in Table 21 show that XRF samples were consistently biased 35 to 45 percent higher than corresponding CLP results. Metals concentrations derived using XRF techniques are expected to be somewhat higher than other analytical techniques because the XRF technique measures total concentration of an element, rather than the leachable portion that is measured by other common techniques (EPA 2000). Relative percent differences (RPD) of 65 to 90 percent were observed in five samples. High RPDs tended to be associated with low metals concentrations. The differences in metals concentrations between XRF and CLP analytical methods cannot be accounted for by the natural variability of soil samples; since XRF is a nondestructive sampling technique, samples that were ground and homogenized for XRF analysis were also submitted for CLP analyses. Figure 51 shows that although the RPDs suggest considerable variations between the two methods, results obtained by both methods were qualitatively comparable, and the difference in analytical technique affected the magnitude but not the shape of the concentration profiles.

Accuracy refers to the degree to which a measured value for a sample agrees with a reference or “true” value for the same sample; in this case, the known concentration of a standard marine sediment (PACS-1). Accuracy can be expressed as deviation from the true value in terms of percent yield, and is derived by dividing the measured value by the true value. The percent yield for copper, lead, and zinc fell within the accepted percent yield range of 85 to 120 percent, and accuracy for these analytes is considered acceptable. Arsenic values for the reference samples fell outside of the acceptable range of accuracy with a 59 percent yield; however, arsenic profiles are discussed in this section since arsenic is a significant ecological concern at the site and the vertical distribution of arsenic is thought to be qualitatively

informative. Cadmium and selenium values were typically close to or below the reliable detection limit of the instrument; as a result, XRF results for these metals are not considered sufficiently accurate to discuss.

4.2.4 Results

Results of the XRF profiling of 13 locations on the marsh surface are presented in Table 22 and are illustrated graphically on Figures 52 through 55. The marsh surface metals profiles show that over most of Litigation Area marsh, metals concentrations are highest at a depth of 3 to 5 inches, and that concentrations decline both above and below that stratigraphic interval. This distribution is consistent with contamination caused by chemical spills in the 1960s and 1970s, followed by gradual burial with cleaner soils as a result of marsh accretion, and meet the data quality objectives defined in the quality assurance project plan for this sampling (TtEMI 2000c). The highest metals concentrations were generally observed in soil core R01SS135, which is adjacent to the remediated area of RASS 2 (for example, see Figures 53 and 55). Elevated zinc concentrations were also observed in core samples R01DH095 and R01SS103 in the southwestern portion of the marsh away from the remediated areas of RASSs 1 and 2. Elevated copper concentrations were detected throughout the eastern half of the marsh, east of Lost Slough.

The metals profiles generally exhibit similar shapes. For example, the shape of the metals concentration profiles in core R01SS135 is comparable for copper, lead, and zinc, suggesting that the metals were deposited concurrently at this location by similar mechanisms. However, the concentration profiles for zinc differ from those of copper and lead in soil cores R01SS103 and R01DH095 at the southwestern portion of the site and cores R01SS091, R01SS264, and R01SS128 at the eastern edge of RASS 1, suggesting that the source of zinc contamination differs from the source of lead and copper contamination. The observed zinc concentration profiles are consistent with zinc discharge to the marsh from Nichols Creek through culverts underneath the railroad tracks. The easternmost lead and copper concentration profiles suggest that the area immediately east of RASS 1 was a source of lead and copper, but was not a primary source of zinc.

Arsenic concentration profiles differ from those of other metals. For example, arsenic concentrations at locations R01SS264 and R01DH261 increase with depth. Further, the highest arsenic concentration was detected at location R01SS083, which has not historically been a hot spot for other metals. The significance of these anomalies associated with arsenic is uncertain; however, since arsenic

concentrations derived using the XRF analytical method fell outside of the acceptable accuracy range for XRF analyses (85 to 120 percent yield), these measurements should be interpreted cautiously.

Metals concentrations were compared with TOC concentrations and current marsh surface elevations to determine whether either of those factors exerted a controlling influence on the observed lateral distribution of metals. XRF metals concentrations from the upper 6 inches of the 10-inch soil cores were averaged together to yield a representative concentration for each metal in each core (Figure 56). Average metals concentrations were plotted against TOC concentrations for corresponding cores, and no correlation between the two values was observed (Figure 56). Vertical variations in organic debris were assessed by reviewing SSC's notations on lithology for each 1-inch slice of each soil core. No correlation was observed between intervals within individual cores that were identified as having a large amount of root material, grass, or wood and elevated metals concentrations for those same intervals.

Soil core samples were collected within approximately 5 feet of the surveyed locations of T-bar marker stakes in the marsh. Average concentrations of each metal in the upper 6 inches of each of the soil cores were plotted against the surveyed elevations of the corresponding T-bar. No correlation was observed between T-bar elevation and metals concentrations in the upper 6 inches of the marsh surface soils. It should be noted, however, that the marsh surface exhibits very little topographic variation (the vast majority of the marsh lies between 2.8 and 3.2 feet above mean sea level [msl]), and the thick vegetation on the marsh surface may have impeded accurate measurement of the elevation of the marsh surface. For example, a stadia rod placed among a dense stand of cattails may not sink to the ground surface to the same extent as a stadia rod in a grassy area or an area with sparse pickleweed vegetation. As a result, surveyed elevations are expected to contain inherent errors that may mask the very limited topographic variation of the marsh. In addition, the marsh surface has accreted 3 to 4 inches of soils since 1960. There is little reason to believe that each area of the marsh has accreted soils at the exact same rate. Accordingly, the relative current elevations of each of the T-bars may not reflect their relative elevations when chemical spills occurring in the 1960s and 1970s. In other words, locations that were in slight topographic depressions in 1960 may not correspond with locations that were topographically depressed when the T-bar locations were surveyed in 1995.

The XRF profiles demonstrate that metals concentrations decline both above and below a contaminated horizon 3 to 5 inches below the marsh surface, suggesting that the marsh is accreting cleaner soils from Lost Slough and that the metals contamination at the marsh surface is not vertically mobile. The locations with the highest concentrations of metals are not correlated with the current marsh surface elevation or with TOC concentration of the soils. As a result, the most likely explanation for the observed distribution

of metals contamination is direct deposition of metals from surface spills followed by accretion of cleaner soils. The geographic distribution of elevated metals concentrations suggests that the primary source of arsenic contamination was to the east of the Litigation Area marsh, the primary source of copper and lead contamination was derived from both south and east of the marsh, and the primary source of zinc contamination was to the south of the Litigation Area marsh. The marsh reference site (MHRSS002) was not significantly contaminated with metals.

4.3 DISCUSSION AND CONCLUSIONS

The preponderance of evidence collected to date indicates that the marsh is accreting soils and that the most contaminated horizons on the marsh surface are being gradually buried by cleaner soils brought into the marsh as suspended solids in Lost Slough. Evidence that supports this hypothesis includes:

1. Continuous turbidity monitoring for 140 tidal cycles during the 1998 to 1999 rainy season showed that water entering the marsh through Lost Slough is more turbid than water exiting the marsh. Statistical analysis of the turbidity data showed that incoming tides had higher turbidity than outgoing tides and that this difference was statistically significant. This finding indicates that Lost Slough imports soils into the Litigation Area marsh, and that these soils are sequestered in the marsh.

2. A soil accretion study performed in 1999 demonstrated that the marsh is accreting soils at a rate of approximately 2.5 mm/yr. The study examined three soil cores from the most contaminated portion of the marsh and used palynological and lead isotope dating techniques to establish the age of several horizons within the soil columns. These two dating techniques established independently that the marsh has been accreting soils in these three locations for the past 200 years, and that average accretion rates are approximately 2.5 mm/yr.

3. Metals profiles from 13 locations across the marsh surface demonstrate that the most contaminated horizon of marsh soils occurs at a depth of 3 to 5 inches below the surface, and that metals concentrations in soils decline both above and below that horizon. This decline in soil concentrations toward the surface is consistent with progressive burial by clean sediments brought into the marsh through Lost Slough, and the 13 profiles demonstrate that an uppermost horizon of cleaner soils is present at location across the entire marsh surface.

The lines of evidence listed above are countered to some degree by five-point measurements of suspended solids concentrations. TSS concentrations in outgoing tides exceeded concentrations in incoming tides in four of five pairs where TSS was measured in conjunction with the long-term turbidity monitoring in 1999. Several researchers have noted that the marshes they studied export organic materials and import inorganic materials (Ward 1981; Settlemyre and Gardner 1977); therefore, the difference in TSS

concentrations between incoming and outgoing tide does not necessarily conflict with accretion of the marsh.

The preponderance of existing evidence indicates that the Litigation Area marsh surface is accreting soils and that the most contaminated horizon lies approximately 3 to 5 inches below the current surface of the marsh. The marsh accretion study showed that the marsh has accreted soils for the past 200 years, and this accretion is expected to continue as long as the same processes operate at the marsh. The calculated marsh accretion rate of 2.5 mm/yr exceeds both the global rate of eustatic sea level rise of 1.2 mm/yr and the apparent rate of sea level rise for San Francisco Bay of 1.5 mm/yr (Stevenson and Ward 1986), suggesting that the crust that the Litigation Area marsh rests on is subsiding. The cause or extent of the local subsidence is unknown; however, tectonism is a likely cause since the San Francisco Bay area is tectonically active. If tectonism causes sudden uplift of the Litigation Area marsh by more than 3 to 5 inches, contaminated soils at the 3 to 5 inch depth horizon may be subjected to gradual erosion. The maximum crustal uplift associated with the Loma Prieta earthquake in 1989 was 14 inches at the epicenter in the Santa Cruz mountains (Marshall and others 1989). If a comparable earthquake occurred with an epicenter near the Litigation Area marsh, crustal uplift could cause eventual erosion of the metals-contaminated soils. However, it should be noted that none of the earthquakes in the past 200 years, including the Great San Francisco Earthquake of 1906 and the Loma Prieta Earthquake caused uplift of the Litigation Area marsh. Although remote, the chance that a major earthquake could cause significant crustal uplift and eventual erosion of Litigation Area marsh soils is acknowledged.

5.0 MOBILIZATION OF SEDIMENTS FROM THE BOTTOM OF THE DITCHES AND SLOUGH

Postremediation monitoring has shown that sediments at the bottom of the ditches and slough are contaminated with metals. Because tidal action moves water through these drainage features twice daily, the potential for mobilization of these contaminated sediments is a concern in the Litigation Area marsh. Metals-contaminated sediments that are mobilized by tidal action during ebb tides have a high potential to be transported out of the marsh and into Suisun Bay. To determine whether sediments mobilize from the bottom of the ditches and slough several special studies were conducted, including two previous investigations (a ditch morphology survey and a Phillip Williams and Associates, Ltd. (PWA) study of sedimentation rates) (Section 5.1) and XRF profiling of ditch and slough bottom sediments (conducted in October 2000) (Section 5.2).

5.1 PREVIOUS INVESTIGATIONS

The Navy conducted two investigations to assess sediment mobility in the bottom of ditches and Lost Slough: ditch morphology survey and hydrological monitoring baseline conditions report.

5.1.1 Ditch Morphology Survey

Because the mosquito ditches are a prominent feature of the marsh surface and the history and shape of ditches were poorly understood, the Navy surveyed three representative mosquito ditches in the most contaminated portion of the site in 1998 to better define their morphology. The ditch morphology investigation is described in detail in the Year 4 monitoring report (TtEMI 1999). The Contra Costa County Mosquito and Vector Control District (CCMVD) installed the ditches in several phases between 1952 and 1969 to control mosquitoes. According to CCMVD, the ditches were installed with earthmoving equipment, and were created at a constant depth of 2 to 3 feet below the marsh surface, with the bottom of the ditches approximately parallel to the marsh surface. The ditches were subsequently reworked between 1974 and 1976, and were again excavated to a constant depth of 2 to 3 feet below the marsh surface.

Longitudinal profiles of the ditches in the eastern portion of RASS 1 (Unit 7) were surveyed at intervals of approximately 100 feet along the entire length of three selected ditches in 1998. Ditch profiling showed that the ditches are 1 to 4 feet wide and 1 to 5 feet deep. The ditches are wide and deep at the proximal end (where the ditches meet Lost Slough) and are narrow and shallow at the distal end (the end furthest from Lost Slough). Figure 57 illustrates the morphology of the ditches. The exact depth of the ditches when they were installed and reworked is not known. However, since the ditches were between 2 and 3 feet deep in 1976, sediments must have subsequently accumulated in areas that are currently less than 2 feet deep and must have eroded from areas where the ditches are currently more than 3 feet deep. The ditch survey revealed that the distal (eastern) ends of the ditches are less than 2 feet deep; these ends are identified as areas of accumulation. The proximal ends (where the ditches join with Lost Slough) are greater than 3 feet deep, and are identified as areas of sediment erosion. Sediment slumping has occurred along the curved area of the southernmost of the three ditches, restricting water flow in portions of the ditch east of the curve. The ditch in the area east of the slumped soils is shallow, suggesting that sediments have accumulated over the entire eastern half of the southernmost ditch (Figure 57).

5.1.2 Hydrologic Monitoring Baseline Conditions Report

PWA performed an additional study of sedimentation in the mosquito ditches in 1989 and 1991 (Fishbain 1994). In this investigation, PWA surveyed cross-sections across the eastern ends of six ditches about 200 feet from the distal end, including the same three ditches that were profiled in 1998. PWA established benchmarks and resurveyed the ditches in the same locations 2 years later. These benchmarks have not been observed in the field since 1991. The resurveying indicated that 0.2 to 0.5 foot of sediment had accumulated in the ditches in the intervening 2-year period. At this rate of sediment accumulation, the ditches would fill completely in 6 to 15 years at most. It is not clear why sediments would accumulate so rapidly in the ditches in the period from 1989 to 1991 or what the margin of error of the PWA study was.

5.2 METALS PROFILES FROM DITCH AND SLOUGH BOTTOMS

The existing postremediation monitoring data show that some locations on the bottoms of the ditches and slough are contaminated with high concentrations of metals. The locations with the highest detected metals concentrations vary from year to year, suggesting that metals-contaminated sediments may be mobile in the ditch and slough system. Assessing mobilization of contaminated sediments from the ditch and slough bottoms poses a more difficult challenge than the marsh surface because the dynamics of the ditches and slough are much more complex than the dynamics of the marsh surface. If the entire marsh surface is gradually rising by accreting sediments, as seems likely from the lines of evidence discussed in Section 4.0, then the slough bottom would be expected to accrete sediments at a comparable rate to maintain a constant cross-sectional area to efficiently transport water into and out of the marsh. However, gradual accretion of sediments on the slough bottom is speculative and is not supported by direct evidence. In addition, the bottom of the slough may be subject to local scouring and filling because of the relatively high flow surface water flow velocities in the slough caused by tidal exchange. Contaminated sediments mobilized from the ditches and slough have the potential to be transported out of the Litigation Area marsh and into Suisun Bay.

Assessing sediment accretion in the mosquito ditches is complicated by several factors. Unlike Lost Slough, the ditches are not equilibrium drainage features that evolved naturally in the marsh. Instead, CCMVD installed the ditches in several phases between 1952 and 1969, and reworked the ditches between 1974 and 1976. According to CCMVD, the ditches were installed and subsequently reworked to a constant depth between 2 and 3 feet below the marsh surface. As discussed above, the portions of the ditches that are shallower than 2 feet are identified as areas of sediment accumulation, and the portions of

the ditches greater than 3 feet deep are identified as areas of sediment erosion. Both the Navy's 1998 ditch survey and the earlier PWA survey identified the distal (eastern) ends of the ditches as areas of accumulation. The Navy survey in 1998 also identified the entire eastern half of the southernmost ditch as an area of sediment accumulation and the proximal ends (where the ditches join with Lost Slough) as areas of sediment depletion.

In October 2000, the Navy collected 21 sediment cores from mosquito ditches and 10 sediment cores from Lost Slough to better define the vertical distribution of metals-contaminated sediments and the potential for mobilization in the slough and ditches. Cores were collected from seven, more or less evenly spaced, locations along the same three ditches that were surveyed in 1998. In Lost Slough, cores were collected from locations that included the junction of the slough with each of the three ditches and seven other locations that have historically exhibited high metals concentrations (Spatial Units 10 and 11).

5.2.1 Field Methods and Sample Preparation

Sediment core samples were collected from the ditches during low tide, when the sampling locations were not inundated or were inundated by no more than a few inches of water at the time of sample collection. Sediment cores were collected by inserting a precut 10-inch-long, 2-inch-diameter acetate sample sleeve into the sediment until the top of the tube was flush with the surrounding sediment surface. The field crew then reached into the semilithified sediments outside of the acetate sleeve, placed a gloved hand over the opening at the bottom of the sleeve, and extracted the sediment-filled sleeve from the subsurface. The sleeves were then capped at both ends with plastic caps lined with Teflon® sheets, wiped clean with paper towels, labeled, and marked with prominent up arrows. Vertical orientations of the sample cores were maintained while the cores were transported to the field trailer, and when the cores were placed in a field freezer. The FSP (TtEMI 2000a) originally called for immediately freezing the sample cores in dry ice after collection in the field. Instead, the cores were transported unfrozen to the field trailer, because the cores would not freeze quickly enough to immobilize the sediments. However, all sample cores were found to be semilithified rather than liquid; as a result, the field freezing was not necessary to prevent rearrangement of liquefied sediments within the acetate sample sleeves. Sample cores were frozen solid overnight in the field freezer, and were shipped to the SSC laboratory with dry ice to maintain their frozen state during shipping. As in the case of the marsh surface cores, 6-inch sample sleeves were advanced into the subsurface adjacent to each ditch and slough sample location, and the samples were analyzed for TOC.

Unanticipated compaction of the sediment column occurred while the sample sleeves were inserted into the sediment. In some cases, this compaction was significant. Sediment compaction of almost 50 percent was recorded in sample locations R01DH120 and R01DH299 in the center of the southernmost ditch. Eight of the 21 ditch samples exhibited sediment compaction of more than 20 percent (less than 8 inches of sediment in a 10-inch sample sleeve). Seven of the 21 samples exhibited sediment compaction of less than 5 percent (more than 9.5 inches of sediment in a 10-inch sample sleeve).

Although sediment cores were collected from slough locations at low tide, these locations were continuously inundated with water, and a different sampling technique was used. Where possible, the field sampling crew set up a temporary ramp into the slough with an extendable aluminum ladder and collected sediment cores from the area adjacent to the ladder in the same manner, as described above. In other locations, the field sampling crew wore chest waders and collected the sample by pushing a 3-foot-long acetate sleeve into the subsurface until the sediment surface outside of the sampling sleeve was 2 feet and 2 inches below the top of the sleeve. The depth to the sediment-water interface inside of the tube was also measured to determine the length of the sediment column inside of the sleeve. The top of the sleeve was then capped with an airtight cap and the sample sleeve was slowly twisted and extracted from the slough bottom sediments. When extracted, the bottom of the acetate sleeve was capped, and the sleeve was punctured just above the sediment-water interface to drain the supernatant water from the sleeve. The length of the sediment column was then measured and compared with the length of the column that was measured in place to verify that little or no sediment dropped from the bottom of the acetate sleeve during extraction.

Because of sample compaction, the sample cores were divided into 10 segments of equal length, rather than into 10 equal 1-inch thick segments. The top six segments and the bottom segment of each core were separated and prepared for analysis. The segments were separated from the frozen sediment core using a pipe cutter to cut the core's acetate sleeve and a stainless steel bread knife to cut through the sediment. A clean bread knife was used at each segment border. The center of each segment of sediment core was then removed with a stainless steel spatula, placed in a foil cup, and dried in an oven overnight. The center portion of each segment was used to reduce the possibility that dragdown along the acetate sleeve would affect the vertical integrity of the sample. After removing from the oven, each dried sample was ground with a mortar and pestle and transferred to an XRF sample cup for analysis.

5.2.2 Results

Results of the XRF analysis of ditch and slough bottom sediment cores are presented in Table 22 and are illustrated on Figures 58 to 65. The concentration scale on each figure has been held constant to illustrate relative concentrations between sediment cores. In addition, elevations of the bottoms of ditches are available for some locations from the ditch morphology survey. TOC and ditch elevation results are presented on Figure 66. Results for the ditch and slough bottoms are presented and discussed separately.

5.2.2.1 Ditch Bottoms

XRF profiles for the ditch bottoms reveal several general trends, but exhibit considerable variation both geographically and among different metals. As discussed above, the distal ends of each ditch and the eastern half of the southernmost ditch have been identified as areas where sediment has accumulated since 1974. Metals concentrations in these sediment profiles tend to be higher than in other areas, indicating that sediments that have accumulated in the ditches are contaminated. These profiles contrast with marsh surface profiles that typically exhibit lower metals concentrations at the surface, and suggest that the source of sediments accumulating on the marsh surface is different from the source of sediments accumulating at the distal ends of the ditches. The difference may be caused by different times of accumulation. Sediments on the marsh surface are believed to accrete gradually but continuously. Sediments that have accumulated in the ditches are known only to have accumulated since the ditches were reexcavated from 1972 to 1974. Sediments that have accumulated at the ends of the ditches may have been scraped from the top surface of the ditch bottoms and deposited at their ends during the reexcavation process. Alternatively, contaminated sediments may originate in the contaminated horizons 3 to 5 inches below the marsh surface, which are exposed in the walls of ditches, or from contaminated portions of the slough.

Ditch bottom cores were collected from two locations (R01DH090 and R01DH260) where erosion of the ditch bottom is suspected because the ditch bottom is more than 3 feet lower than the marsh surface (the maximum excavation depth according to CCMVD). The ditch bottoms at locations R01DH090 and R01DH260 have elevations of 3.1 and 3.4 feet below the marsh surface. Because the ditch bottom at these locations is greater than 3 feet below the marsh surface, the entire sediment column collected at these locations represents sediments that are unlikely to have accumulated since the ditches were originally excavated in the 1950s and 1960s. These sediment cores exhibit some puzzling aspects. Sediment core R01DH260 shows apparent accumulation of copper- and lead-contaminated sediments in the upper 2 inches. Sediment core R01DH090 shows an increase in copper, lead, and zinc concentrations

with depth. The significance of these features is uncertain. One possible explanation is that the ditches were deeper than 3 feet at one time and they have subsequently accumulated sediment.

In areas where sediments are not know to have either accumulated or been eroded (the central reaches of the ditches), metals concentrations in sediments are relatively low compared with the areas of known accumulation (the eastern ends of the ditches) and are generally more or less constant with depth.

Profiles of arsenic, copper, and lead concentrations at a single location are generally comparable, presenting little evidence of different sources for or mobility of these metals. For example, the arsenic, copper, and lead profiles at locations R01DH266 and R01DH300 in the southernmost ditch and at locations R01DH290 and R01DH250 in the center of the northern ditch have comparable shapes. The zinc profile in these locations differs from that of the other three metals, suggesting that (1) zinc originated from a different source area, and (2) zinc has mobilized since zinc-contaminated sediments were deposited. High concentrations of zinc in the deepest samples from the center of the northern ditch (R01DH090, R01DH290, and R01DH291) suggest that zinc and other metals in ditch bottom sediments may have mobilized vertically. It is difficult to imagine that metals-contaminated sediments were deposited in the ditches at a depth of almost 4 feet below the marsh surface. High concentrations of zinc were also observed at a depth of approximately 2 feet below the marsh surface at location R01SH264 during the sediment accretion study. Other metals at the same depth horizon in this sample were not elevated. Location R01SH264 is approximately 50 feet from the nearest mosquito ditch. Because the sediment horizon at this depth appears to have been deposited around 200 years ago, before European settlement of the San Francisco Bay area, it seems unlikely that zinc at this depth represents in-place contaminated sediments. Zinc concentrations observed at depth in the ditch bottom samples and at marsh surface location R01DH265 suggest that zinc is vertically mobile to some degree or is naturally occurring.

It is difficult to interpret the significance of the metals concentration profiles from the ditch sediment cores. Several general conclusions can be drawn from the ditch metals concentration profiles (Figures 58 to 61):

1. Known areas of sediment accumulation (where the ditch bottom is less than 2 feet below the marsh surface) generally exhibit higher metals concentrations than other areas. Sediments that have accumulated in these areas since 1974 have elevated metals concentrations, unlike sediments that have accumulated on the marsh surface since 1974, which have low metals concentrations, suggesting different sources for the accumulating sediments in these two locations.

2. Known areas of erosion (where the ditch bottom is more than 3 feet below the ditch surface) exhibit evidence of contamination by copper, lead, and zinc. One possible explanation is that the ditches were at one time deeper than 3 feet and they have subsequently accumulated contaminated sediments. A second possibility is that localized geochemical conditions are favorable for vertical migration of metals.

3. Areas where sediments are not known to have either accumulated or been eroded generally have low metals concentrations compared with the areas of known accumulation; these areas are generally more or less constant with depth.

4. Profiles of arsenic, copper, and lead concentrations with depth at a single location are generally comparable, presenting little evidence for different sources for, or mobility of, these metals. The zinc profile sometimes differs from that of the other metals, suggesting that zinc originated from a different source area than the other three metals and that zinc has mobilized since the zinc-contaminated sediments were deposited.

5.2.2.2 Slough Bottoms

Sediment cores were collected from the bottom of the slough at 10 locations where previous sampling had shown that contaminated sediments were present. XRF profiles for the slough bottom samples reveal several general trends and considerable geographic variation. Unlike ditch bottom sediments, all four metals profiled typically exhibit similar concentration profiles, with the exception of arsenic at R01SH254.

The most significant general feature of the slough bottom concentration profiles is that half of the profiles exhibit the shape that would be expected if the slough accreted cleaner sediments at a rate comparable with that observed at the marsh surface. Five of the profiles exhibit a prominent concentration peak at about 4 to 6 inches below the surface, and metals concentrations decline both above and below that horizon (for example, see zinc concentration profiles for locations R01SH055, R01SH254, R01SH098, R01SH130, and R0SH132 on Figure 65). The other half of the concentration profiles exhibits a more-or-less constant concentration or a moderate increase in concentration with depth (for example, see location R01SH082 on Figures 64 and 65, and location R01SH105 on Figure 62). In all cases except location R01SH112, surficial sediments have lower metals concentrations than sediments at depth. At R01SH112, concentrations decrease with depth, suggesting that contaminated sediments have accumulated there. XRF profiles of the slough bottom sediments are consistent with accretion and gradual burial of contaminated horizons by cleaner sediments.

The profiles that show apparent accretion of cleaner sediments (decline in concentration above and below a peak) are separated by profiles that show no apparent accretion, indicating that accretion of sediments on the slough bottom occurs discontinuously. The pronounced increases in zinc concentrations with

depth that were observed in ditch sediment cores R01SH090, R01SH290, and R01SH250 were not observed in any slough sediment core, suggesting that vertical mobilization of zinc is not pronounced in the sloughs or that zinc-contaminated sediments have not been scoured and redeposited to the same extent as in the ditches.

Arsenic, copper, and lead concentrations in slough bottom sediments were lower than in ditch bottom sediments, suggesting that these metals were preferentially deposited on the marsh surface and on the ditch bottoms. Zinc concentrations were comparable in the ditch and slough bottom sediments. This comparison suggests that the observed zinc contamination originated from a different area than the observed copper, lead, and arsenic contamination.

5.3 DISCUSSION AND CONCLUSIONS

The significance of the ditch and slough bottom sediment concentration profile data is difficult to assess. The overall objective of obtaining vertical profiles of metals concentrations in ditch and slough bottoms was to provide evidence to assess whether metals-contaminated sediments are mobile within the slough and ditch system. Because of the observed variations, the mobility of ditch and slough bottom sediments can not be definitively characterized. Based on the discussion above, several significant conclusions may be drawn.

First, metals-contaminated sediments that have accumulated in the distal ends of the ditches do not appear to be from the same source as sediments that cover the marsh surface. Sediments that have accumulated in the distal portions of the ditches have much higher metals concentrations than sediments that have accreted on the marsh surface.

Second, slough bottom sediments exhibit metals concentrations profiles that are similar to those of the marsh surface, suggesting that sediment in the marsh surface and the slough bottom have accreted through similar processes. However, the accretion of sediments on the slough bottom appears to be more localized than on the marsh surface. Sediment cores from the slough bottom that exhibit a peak at depths of 4 to 6 inches below the surface, with declining concentrations both above and below that horizon, are separated by cores with more or less constant metals concentration profiles or profiles that show a moderate increase in concentrations with depth.

Finally, the concentration profiles show some evidence of vertical mobilization of zinc from the northernmost mosquito ditch, and to a lesser extent from the slough bottom and marsh surface. An

alternative explanation for the observed concentration increase with depth is scouring and subsequent redeposition of contaminated sediments.

Overall, the sediment concentration profiles provide evidence that contaminated sediments have accumulated in some areas, implying that contaminated sediments entering the ditches and slough do not necessarily mobilize into Suisun Bay. The evidence of accretion in Lost Slough suggests that gradual burial of contaminated sediments with cleaner sediments is occurring in some locations. The fact that surficial sediments typically have low metals concentrations compared with deeper sediments indicates that rapid flow across the ditch and slough surface, which might occur during spring tides or storms, is not likely to mobilize the most contaminated sediments. In addition, ecological receptors residing in oxic surface sediments are not typically exposed to the highest observed concentrations in the sediment. Surficial sediments at the distal ends of the ditches are among the most contaminated at the site, and flow across these surfaces could mobilize the sediments. However, the observed shallow depths at the distal ends of the ditches suggest that these are areas of sediment accumulation rather than mobilization.

6.0 MIGRATION OF CONTAMINANTS TO SUISUN BAY THROUGH LOST SLOUGH

Potential migration of contaminants from the Litigation Area into Suisun Bay through tidal discharge from Lost Slough has been one concern that the Navy has addressed through annual postremediation monitoring over the 5-year monitoring period, which included special studies. Surface water discharge to Suisun Bay has been assessed by collecting surface water samples at 22 locations along the northern reach of Lost Slough closest to Suisun Bay (Unit 9) during outgoing tides. Beginning in 1997, the Navy began conducting focused studies to further define the dynamics of marsh surface drainage and potential contaminant migration and to determine whether Lost Slough acts as a conduit for contaminant migration in surface water from the Litigation Area marsh to Suisun Bay. Section 6.1 discusses the results of previous investigations (the tidal influence study, wet season storm sampling, and tidal water quality sampling in 1999), and Section 6.2 discusses the results of the tidal water quality sampling in the fall of 2000. Section 6.3 summarizes the discussions and conclusions of Sections 6.1 and 6.2.

6.1 PREVIOUS INVESTIGATIONS

In addition to annual surface water monitoring, the Navy conducted three focused studies to investigate whether tidal action causes mobilization of contaminants from the Litigation Area marsh. These studies included (1) a tidal influence study (TtEMI 1997), (2) winter storm surface water monitoring (TtEMI 2000a), and (3) tidal water quality sampling in 1999 and 2000 (TtEMI 2000a). Each of these studies is discussed separately and conclusions are summarized in Section 6.3.

6.1.1 Tidal Influence Study

A tidal influence study was conducted from September 27 to October 2, 1997, to evaluate the effects of tidal variations on groundwater and surface water in the Litigation Area marsh. The study was conducted by monitoring surface water elevation, electrical conductivity, and temperature at nine locations: five groundwater monitoring wells; the RASS 3 pond; and three locations in Lost Slough, including the slough mouth and two locations in the upper slough (TtEMI 1997).

Temperature and electrical conductivity of groundwater and surface water were continuously monitored for 10 tidal cycles, and salinity was calculated from these data using the practical salinity scale of 1978 (Lewis 1980). These calculations showed that surface water salinity in Lost Slough varied spatially from approximately 4.5 parts per thousand (ppt) to 9 ppt, or from about one-eighth to one-fourth the salinity of sea water. Higher salinities were observed in the middle and upper (southern) portions of Lost Slough, and salinities at the bridge mouth were 2 to 3 ppt lower throughout each tidal cycle. These data indicate that surface water in the ditches and upper reaches of the slough does not exit the slough without significant dilution with water from Suisun Bay. If surface water from Lost Slough was completely exchanged with surface water from Suisun Bay during each tidal cycle, salinity variations along the length of Lost Slough such as those observed in 1997 could not be maintained, and the salinity at the bridge monitoring location would equal that of the water from the upper reaches of the slough at some point in the tidal cycle. Because significant salinity variations along the length of slough were maintained and because salinity at the slough mouth was never equal to the higher values observed in the upper reaches, it appears that water from the upper reaches of the slough never exits the marsh without significant mixing with lower salinity water. Instead, high salinity water from the upper slough appears to be pushed back and forth as a discrete slug of water in the upper reaches of the slough during rising and falling tides, and it appears that limited mixing of high salinity slough water and low salinity Suisun Bay water occurs only in the lower reaches of the slough.

6.1.2 Wet Season Storm Sampling (Winter 1999)

In response to observations and measurements that suggested that winter storms may mobilize significant amounts of sediment, the Navy collected surface water samples from 12 locations in the Litigation Area marsh during three separate winter storms during the 1998 to 1999 wet season. The objective of this work was to determine whether winter storms are significant sediment mobilization events by comparing total metals concentrations collected during winter storms with the annual postremediation monitoring data collected at the same locations during the annual monitoring in the dry season. A second objective

of the work was to compare metals concentrations in surface water in the marsh with ambient water quality criteria (AWQC). This focused sampling event is fully described in the year 5 remedial action monitoring report (TtEMI 2000a).

The field team attempted to collect samples when the potential for mobilization was highest (when major winter storms coincided with unusually high outgoing tides). Unfortunately, significant rain events (defined as greater than 0.2 inch in the previous 24 hours) did not coincide with unusually high outgoing tides (defined as greater than 3 feet above msl) during the early part of the 1999 rainy season. Accordingly, samples were collected during storm events that coincided with moderately high outgoing tides.

Both filtered and unfiltered samples were collected during or shortly after each storm. With the exception of copper, metals concentrations in the filtered samples rarely exceeded AWQC. Copper concentrations in filtered samples consistently exceeded the marine criterion continuous concentration (CCC) of 3.1 µg/L. Total metals concentrations were typically only slightly higher than filtered metals concentrations for the three sets of winter storm samples, indicating that metals were transported primarily as a dissolved phase during the winter storm sampling. This result contrasts sharply with surface water samples collected during the summer months, when total metals concentrations significantly exceeded dissolved metals concentrations in most cases. The contrast is probably closely related to the contrast in suspended solids concentrations between the summer sampling events and the winter storm sampling; TSS concentrations of the May 1999 dry season samples had a median value of 82.5 mg/L, as opposed to the winter storm samples, which had a median value of 18 mg/L. A student t-test showed that TSS concentrations in the dry season samples were statistically higher than in winter storm samples from the same locations, and that the difference was statistically significant. TSS concentrations are not available for the other three dry season sampling events (August 1995, June 1997, and June 1998).

The winter storm sampling demonstrated that sediments and associated metals do not appear to be mobilized to a significant extent during winter storms and that AWQC were consistently exceeded only for copper; other metals only sporadically exceeded AWQC.

6.1.3 Tidal Water Quality Sampling (Winter 1999)

One of the primary concerns in the Litigation Area is the potential impact that contamination in the marsh may have on surface water quality in Suisun Bay. Tidal flooding typically inundates the Litigation Area marsh twice daily, and an elevated lip along the shoreline of Suisun Bay directs essentially all of the

surface water that enters and exits the marsh through the mouth of Lost Slough. The Navy conducted tidal water quality sampling at the mouth of Lost Slough during the winter of 1999 to assess the quality of water entering and exiting the marsh. Surface water entering and exiting the slough during the wet season was characterized by collecting samples at the mouth of the slough at 2-week intervals on five separate dates. Tidal water quality sampling conducted in 1999 is described in detail in the year 5 monitoring report (TtEMI 1999).

Depth-discrete surface water samples were collected at the bridge near the mouth of Lost Slough from about 3 feet above the bottom of the slough. Samples were analyzed for total and dissolved metals, TDS, TSS, and hardness. Separate aliquots of water were collected from the slough for the filtered and unfiltered metals samples. Samples were collected during both incoming and outgoing tides to allow direct comparison of ambient water quality entering the slough from Suisun Bay with water quality exiting the slough.

Analytical results for the 1999 tidal water quality sampling (Table 23) show that no obvious differences exist in the quality of water entering and exiting the Litigation Area marsh. A large proportion (almost 70 percent) of the analytical results either was below detection limits or was qualified as nondetected during data validation. For brevity, the laboratory-reported detection limit or reported concentrations that were qualified as nondetected during data validation are considered the detection limit for each sample. Detection limits and detected concentrations were lower than AWQC for all metals except copper, indicating that water entering and exiting the Litigation Area marsh does not exceed applicable water quality criteria. This result is surprising, considering that total metals concentrations at many of the 12 winter storm sampling locations within the Litigation Area marsh exceeded AWQC for arsenic, cadmium, copper, lead, and zinc. The most likely explanation is that water in the upper reaches of the slough moves back and forth in response to rising and falling tides, but does not exit the slough without significant dilution. This interpretation is consistent with salinity gradients within the slough observed in the tidal influence study conducted in 1997 (TtEMI 1997). That study showed that salinity in the upper reaches of the slough varied in response to tides, but was always higher in the upper reaches of the slough than at the mouth of the slough (TtEMI 1997). Salinity data from the 1997 tidal influence study indicate that any water leaving the Litigation Area marsh through Lost Slough is diluted with lower salinity water from Suisun Bay before leaving the marsh.

The detection limit for copper consistently exceeded the AWQC of 3.1 µg/L. A total of 22 samples of tidal water were analyzed, including filtered and unfiltered samples from 5 incoming and outgoing tides and 2 duplicate samples. Detection limits for copper exceeded the AWQC in 8 of 10 samples from

incoming tides and 9 of 12 samples from outgoing tides. Copper concentrations in each of the five remaining samples exceeded AWQC. Copper concentrations of 6.9 to 10.6 µg/L were detected in incoming tides. Copper concentrations of 7.9 to 11.3 µg/L were detected in outgoing tides. Although the number of samples is small (results are available for only one incoming and outgoing tidal cycle), the copper concentration did not differ significantly between incoming and outgoing tides during this tidal cycle.

Tidal water quality sampling conducted during the winter of 1999 showed that the majority of samples from both incoming and outgoing tides were below detection limits and AWQC. No results for arsenic, cadmium, lead, selenium, or zinc exceeded AWQC. Results for copper were more problematical because the detection limit exceeded AWQC in the 17 samples in which copper was not detected. In the remaining five samples, copper was detected at concentrations ranging from 6.9 to 11.3 µg/L. Copper concentrations were comparable in the single set of incoming and outgoing tide samples for which data are available, suggesting that the Litigation Area marsh does not export copper to Suisun Bay. Analytical results for the tidal water quality samples suggest that water quality exiting Lost Slough is generally comparable with overall water quality entering the slough from Suisun Bay. In 1999, outgoing tides contained slightly higher concentrations of arsenic, cadmium, and zinc. In 2000, incoming tides contained slightly higher concentrations of cadmium, selenium, and zinc.

6.2 TIDAL WATER QUALITY SAMPLING (FALL 2000)

Tidal water quality sampling was repeated in October 2000 to characterize water quality entering and exiting the marsh at the end of the dry season. Tidal water quality samples were collected in October 2000 using techniques identical to those used to collect the samples in 1999 (Section 6.1.3) to maintain comparability between the two data sets. Exceptions included (1) water samples from outgoing tides were collected about 1 hour before low tide, rather than midway through the outgoing tide, to characterize the least diluted water exiting the slough from the furthest reaches of the slough and ditches; (2) samples were collected on discontinuous dates (October 5, 6, 20, 23, and 24), rather than at 2-week intervals, because of logistical considerations; and (3) metals samples were composited in the same sampling jug, transported to the field trailer, mixed thoroughly, and then pumped from the jug directly into preserved sample bottle (for the unfiltered sample) and through a 0.45 micron in-line filter into a preserved sample bottle (for the filtered metals sample). Analytical results for the filtered and unfiltered sample pairs are presented in Table 23.

Samples collected in 1999 were analyzed by Applied Physics and Chemistry Laboratory (APCL) in Chino, California. Samples collected in 2000 were analyzed by STL in University Park, Illinois. Both laboratories used inductively coupled plasma (ICP) trace techniques, but STL was able to achieve lower detection limits for the samples collected in 2000 than APCL. Detection limits for 13 of the 16 samples in which copper was not detected exceeded the AWQC of 3.1 µg/L. Although STL was able to lower the detection limit for copper from an average of 9.9 µg/L for the samples collected in 1999 to 5.5 µg/L for the samples collected in 2000, neither laboratory was able to consistently achieve a detection limit below the AWQC for copper.

Review of data presented in Table 23 shows that data collected at the end of the dry season in the fall of 2000 was comparable with data collected during the winter of 1999. Analytical results presented in Table 23 show that no obvious differences exist in the quality of water entering and exiting the Litigation Area marsh. As described in Section 6.1.3, the laboratory-reported detection limit or reported concentrations that were qualified as nondetected during data validation are referred to as the detection limit for each sample for brevity. Almost 95 percent of the analytical results from sampling conducted in 2000 were below detection limits, and all detection limits, except those for copper and selenium, were lower than AWQC, indicating that water entering and exiting the Litigation Area marsh does not generally exceed applicable water quality criteria. The detection limit for selenium exceeded AWQC for total and filtered samples from one outgoing tide. Selenium detection limits for all other samples were lower than the AWQC of 4.6 µg/L.

Only copper, selenium, and zinc were detected in the tidal water quality samples collected in 2000. Copper was detected at comparable concentrations of 1.8 to 29.5 µg/L in three incoming tides and three outgoing tides. Selenium was detected in two incoming tides at concentrations of 2.6 to 8.3 µg/L, but was not detected in outgoing tides. Zinc was detected at comparable concentrations (6.7 to 25.2 µg/L) in three incoming tides and two outgoing tides. Detected concentrations were below AWQC for all metals, except copper and selenium.

6.2.1 California Regional Water Quality Control Board Sampling

RWQCB collected surface water samples from incoming and outgoing tides on October 6 and 20 at a location about 50 yards south of the bridge location where the Navy samples were collected. Because RWQCB samples were collected at approximately the same time and place as two of the Navy samples, water quality in the two sets of samples should be comparable. However, RWQCB collected the samples using ultraclean field sampling techniques and analyzed the samples using EPA Method 1638 (ICP and

mass spectrometer [ICP/MS]) analytical techniques; as a result, the two sets of results can be expected to differ.

RWQCB also collected samples on October 20 at a nearby location in Lost Slough. Location R01SH221 is about 500 feet from the bridge and 150 feet from the junction of Lost Slough and the north-south cut that leads up to the bridge. RWQCB collected and analyzed the samples of incoming and outgoing tides at R01SH221 using ultraclean sampling techniques and ICP/MS analytical techniques.

Navy and RWQCB data from these sampling events are presented in Table 24. Data show that metals concentrations in water entering the marsh were comparable with concentrations in water exiting the marsh for each of the six metals tested, and that dissolved metals concentrations did not exceed AWQC for any metal. RWQCB results from location R01SH221 showed no significant difference from samples collected at the same time at the location 50 yards south of the bridge, further demonstrating that copper concentrations in incoming tides are comparable with those in outgoing tides. Total copper concentrations (maximum concentration of 5.72 µg/L) exceeded the AWQC for copper (3.1 µg/L), but no other total metals concentrations exceeded AWQC. The ICP/MS analytical technique used by RWQCB achieved significantly lower detection limits for copper than the ICP-trace analytical technique used by the Navy. RWQCB results show that copper was present in both incoming and outgoing tides at concentrations ranging from 1.64 to 1.77 µg/L. Both RWQCB data and Navy data for copper indicate that copper concentrations in incoming tides are comparable with those in outgoing tides. However, RWQCB data have a lower detection limit and fewer nondetected results.

6.2.2 Analytical Data Quality

One puzzling aspect of the data from the Navy's filtered and unfiltered sample pairs is that many of the metals concentrations in the filtered samples exceed concentrations in the unfiltered samples. Because the filtration process is expected to exclude that portion of the metals that are associated with suspended particles, this feature of the data is counterintuitive, yet it is persistent across different sampling events and laboratories. The problem affects copper concentrations in particular.

To better define the problem, all of the filtered and unfiltered metals pairs collected to date were examined. These pairs included samples collected during the winter storm sampling and the tidal water quality sampling (Sections 6.1.2 and 6.1.3), in addition to samples collected from Nichols Creek in 1998, water samples collected from bioassay sample locations in 2000, and sets of samples collected from the ditches and slough during normal postremediation monitoring in 1998 and 1999. In all, 120 filtered and

unfiltered sample pairs were collected during 7 separate sampling events from 1998 to the present. Analytical results for the filtered and unfiltered pairs are summarized in Table 25.

Review of the data in Table 25 shows that 23 filtered copper results (19 percent of the total number of filtered and unfiltered pairs) exceeded unfiltered results by 10 percent or more, and 13 filtered copper results (11 percent of the total number of filtered and unfiltered pairs) exceeded unfiltered results by a factor of 2. Nondetected results were treated numerically as one-half of the detection limit.

Several possible explanations were considered for why the filtered concentrations exceeded total concentrations in a relatively high percentage of the data:

- The first and most obvious possibility is that the filtered and unfiltered samples were mislabeled in the field. This possibility was discounted because aluminum results in the unfiltered samples were consistently much higher than in the filtered samples, as would be expected if the filtered and unfiltered samples were correctly labeled.

- A second possibility is that the process of filtering the samples somehow introduced copper into the filtered samples. This possibility was discounted by examining equipment blank samples; copper concentrations in the filtered equipment blank samples did not exceed concentrations in the unfiltered samples.

- A third possibility was systematic sampling bias. The filtered and unfiltered samples collected in the winter of 1999 were different aliquots of water. It is possible that one of the aliquots contained more suspended sediments that somehow affected the effectiveness of the filter. This possibility is discounted because the suspended solids concentrations in the samples are well below concentrations that could cause filter breakthrough. In addition, samples collected in the fall of 2000 were composited in a single sampling jug before filtering, yet still exhibited filtered concentrations that were higher than unfiltered concentrations.

- A fourth possible explanation was systematic laboratory bias, such as interelement interference from other analytes. This possibility is considered unlikely because the concentrations of major ions that could cause interference with copper (calcium, magnesium, potassium, and sodium) are not present at substantially different concentrations in the filtered and unfiltered samples. If the presence of these compounds caused analytical interference, the interference would be approximately equal in both filtered and unfiltered samples.

The explanation for the counterintuitive results for filtered and unfiltered copper concentrations is not known. The most likely possibility seems to be analytical uncertainty at concentrations below the reporting limit. The method used to analyze these samples (EPA Method 6010, ICP trace) has a contract-required detection limit (CRDL) of 25 µg/L. At concentrations below the CRDL, minor instrument variations can have a disproportionate effect. The vast majority of the analytical results were below the

CRDL of 25 µg/L. An analytical technique such as ICP/MS that can achieve a lower detection limit should be used for future analyses of copper in surface water.

6.3 DISCUSSIONS AND CONCLUSIONS

The Navy has conducted focused studies to determine whether Lost Slough acts as a conduit that conveys contaminants from the Litigation Area marsh to Suisun Bay. These studies included a 1997 tidal influence study that demonstrated that water draining from Lost Slough undergoes significant dilution before discharging to Suisun Bay (TtEMI 1997). The winter storm sampling conducted during the winter of 1998 to 1999 demonstrated that sediments and associated metals do not appear to be mobilized to a significant extent during winter storms, and that AWQC were consistently exceeded only for copper (TtEMI 1999).

Tidal water quality samples were collected at the mouth of Lost Slough during the winter of 1998 to 1999 and the fall of 2000. Both sets of samples showed the same general features; the quality of water entering and exiting the Litigation Area marsh during both sampling events was generally comparable. A large proportion (almost 70 percent) of the analytical results for the winter of 1998 to 1999 were either below detection limits or were qualified as nondetected during data validation. Detection limits and detected concentrations were lower than AWQC for all metals, except copper, indicating that water entering and exiting the Litigation Area marsh does not exceed applicable water quality criteria. Almost 95 percent of the analytical results from the fall of 2000 were below detection limits, and detection limits were lower than AWQC for all metals, except copper. Copper was detected in both incoming and outgoing tides in a set of samples from a single tidal cycle on March 5, 1999. Copper concentrations in the incoming and outgoing tides in this sample set were comparable and exceeded AWQC, indicating that the Litigation Area marsh does not export copper to Suisun Bay. Incoming and outgoing tides exceeded AWQC for copper in both sets of tidal water quality samples.

Analytical results for copper were compromised to some extent by an analytical detection limit for copper that was high in comparison with the marine CCC of 3.1 µg/L. The Navy used different laboratories to analyze samples collected in the winter of 1998 to 1999 samples and the fall of 2000, and the new laboratory was able to achieve a lower detection limit for copper than the previous laboratory. However, the detection limit achieved by the new laboratory still exceeded the AWQC of 3.1 µg/L for copper. Analytical results for copper were also affected by an unexplained artifact that caused filtered concentrations to exceed unfiltered concentrations.

RWQCB collected samples at two nearby locations during tidal water quality sampling in the fall of 2000, but used a different analytical technique that consistently achieved lower detection limits. RWQCB samples showed that no dissolved metals concentrations exceeded AWQC and that metals concentrations in incoming tides were comparable with concentrations in outgoing tides. RWQCB samples showed no significant difference between samples collected at the junction of Lost Slough with the north-south cut that leads to the bridge sampling location, and a different location further up Lost Slough.

Samples collected to date strongly suggest that the Litigation Area marsh does not export significant concentrations of metals to Suisun Bay through Lost Slough. Detection limits and detected concentrations for all metals (except copper) were below AWQC. Detected concentrations in incoming tides were generally comparable with those in outgoing tides. For copper, the analytical laboratory used by the Navy was unable to achieve a low detection limit; therefore, the conclusion that copper concentrations in incoming tides are comparable with those in outgoing tides is based on a limited number of samples. However, this conclusion is supported by three sets of samples collected and analyzed by RWQCB that show that copper concentrations in incoming and outgoing tides were for all practical purposes identical, and below the marine CCC of 3.1 µg/L.

7.0 GROUNDWATER ISSUES

The Navy recognizes the potential for groundwater to act as a migration pathway that could transport contaminants from the Litigation Area marsh to Suisun Bay or to nearby drinking water aquifers and has addressed this potential by conducting groundwater monitoring and a tidal influence study to ascertain the degree of groundwater and surface water interaction. The groundwater work conducted to date included sampling before, during, and after remediation; surveying water levels; and reviewing relevant investigations on neighboring properties. The following sections discuss the groundwater issues in the Litigation Area, including (1) groundwater flow directions and velocities (Section 7.1), (2) groundwater contamination detected both on- and off-site (Section 7.2), (3) groundwater and surface water interaction (Section 7.3), and (4) a description of the rationale for presuming that groundwater should be classified as nonpotable (Section 7.4). Section 7.5 presents the conclusions based on the groundwater studies and sampling conducted to date about groundwater in the Litigation Area.

7.1 GROUNDWATER FLOW VELOCITIES AND DIRECTIONS

Groundwater in the Litigation Area occurs in a shallow, unconfined water-bearing zone. Depth to water varies because of topographic variation across the site. In the marsh area, groundwater is encountered at

depths of 2 to 5 feet below grade. Further inland, groundwater occurs more than 40 feet below grade (well 3MG14). Groundwater elevations are typically low, ranging from msl to 6.4 feet above msl.

Water level surveys of the Litigation Area wells were conducted on 13 occasions from 1991 to 1996. Water level surveys from 1991 to 1994 typically spanned several days, and results were reported in the hydrogeological data compilation report (PRC 1994). The 1996 water level survey was conducted in a single day and is reported in the postremediation groundwater sampling technical memorandum (TtEMI 1997). To illustrate the range of variability of the potentiometric surface in the Litigation Area marsh, potentiometric surface maps were constructed from historically high and low water levels in the marsh. Figure 67 illustrates flow directions in the marsh during drought conditions when water levels in the marsh were low. Figure 68 illustrates flow directions in the marsh at the end of the wet season when water levels in the marsh were 2 to 4 feet higher.

The potentiometric surface maps from these water level surveys share the same major features. Groundwater in the Litigation Area generally flows to the north or northwest toward the tidal wetlands. An elongated groundwater mound is present near wells 3MG11, 3MG12, and 3MG13, which roughly coincides with Nichols Creek and directs groundwater flow toward the southwest, in the area west of Nichols Creek. The groundwater mound in these wells suggests that Nichols Creek is a losing creek in this reach, which is supported by field observations in October 2000, when water was observed flowing in Nichols Creek south of the railroad tracks, but the creek bed was dry in the area north of the railroad tracks.

Temporary reversals in groundwater flow direction have been observed in the Litigation Area. In October 1996, groundwater flow was directed to the east in the north-central portion of the Litigation Area (near wells 1AG02, 1AG03, and 1AG04), as opposed to the more typical westward flow in this area observed during 11 other water level surveys. Water levels were measured 2 weeks later in these wells after a period of heavy rainfall. Water levels in the wells rose by as much as 3 feet, and the more typical westward flow pattern resumed. Although a reversal in flow direction was observed in October 1996, the flow reversal appears to be an unusual circumstance of short duration.

Groundwater flow in RASS 4 (wells 4MG15, 4MG16, and 4MG17) is highly variable. In May 1990 and March 1993, groundwater flow in this area was directed toward the south. At other times, flow is directed to the northeast, southeast, or west, with no apparent seasonal cause for variations in flow direction.

Seepage velocity, the average rate at which groundwater moves between two points, was calculated using the following equation (Fetter 1994):

$$\text{seepage velocity} = Ki / \theta_e \qquad (7\text{-}1)$$

where:

K= hydraulic conductivity (centimeter per second [cm/sec])

i = hydraulic gradient (dimensionless)

θ_e = effective porosity of the material (dimensionless)

Site-specific hydraulic conductivity information is not available for the Litigation Area wells. IT conducted laboratory permeability tests at the neighboring GCC facility and reported conductivities of 1.7×10^{-5} to 3.6×10^{-7} cm/sec for the silty clay material and 1.8×10^{-4} to 9.3×10^{-5} cm/sec for silty sand materials (IT 1999a). These values are in the center of the range of values for silt and silty sand reported by Freeze and Cherry (1979). Very low hydraulic conductivity of the silty clay material beneath the Litigation Area marsh is supported by groundwater sampling conducted in October 1996, which showed that wells screened within the silty clay material were unable to yield 0.1 liter of groundwater per minute without significant drawdown.

Maximum hydraulic gradients varied from 0.008 between wells 3MG11 and 2MG21 in March 1993 to 0.001 between wells 3MG11 and 2AG08 in May 1990. Site-specific measurements of effective porosity are not available for the Litigation Area; therefore, reasonable values were assumed based on ranges reported in the literature. Effective porosity was approximated by using specific yield values because specific yield values are more representative of interconnected porosity in fine-grained materials than bulk porosity values (Todd 1980). Todd (1980) reports specific yields of 0.08 for silt and 0.03 for clay; therefore, an intermediate value of 0.06 was assumed to be the effective porosity of the Bay Mud that underlies the Litigation Area marsh. Todd (1980) reports specific yield of 0.08 for silt and 0.23 for sand; therefore, an intermediate value of 0.16 was assumed to be the effective porosity of the silty sand lenses that underlie the Litigation Area marsh.

A maximum seepage velocity of 0.7 meter per year (2.3 feet per year) was estimated for the silty clay that underlies the marsh, assuming the maximum measured hydraulic conductivity for silty clay in the area (1.7×10^{-5} cm/sec), the maximum hydraulic gradient (0.008), and an effective porosity of 0.06. A maximum seepage velocity of 2.8 meters per year (9.3 feet per year) was estimated for the silty sand lenses that underlie the site, assuming the maximum measured hydraulic conductivity for silty sand in the area (1.8×10^{-4} cm/sec), the maximum hydraulic gradient (0.008), and an effective porosity of 0.16. These sand lenses have limited extent in the direction of groundwater flow; therefore, groundwater may flow at rates as high as 9.3 feet per year, but only for short distances within the sand lenses.

Because the wells are approximately 2,000 feet from the shoreline of Suisun Bay, any contamination detected in the monitoring wells would take approximately 870 years to reach the shoreline of Suisun Bay. It should be noted that this travel time is based on the maximum observed hydraulic gradient of 0.008, which drops substantially under the Litigation Area marsh. Groundwater would actually take more than 870 years to traverse the marsh and reach the Suisun Bay shoreline because the decreased hydraulic gradients beneath the marsh would cause groundwater to travel more slowly than 2.3 feet per year. Because the well logs for wells 1PG05, 2AG07, 2AG08, and 2AG09 show that no sand lenses are present and the wells are all located at least 150 feet from the nearest mosquito ditch, groundwater would be expected to travel at a maximum rate of 2.3 feet per year in this area. Accordingly, any groundwater contamination observed in these wells would take a minimum of 65 years to reach the nearest mosquito ditch. Because gradients in the area between the wells and the ditches are expected to be lower than the maximum of 0.008, actual travel times are likely to be longer.

7.2 GROUNDWATER CONTAMINATION

Groundwater in the Litigation Area and in upgradient sites has been monitored periodically since 1987. The following sections describe the results of groundwater monitoring conducted to date.

7.2.1 On-site Groundwater Monitoring

Twenty-two monitoring wells have been installed to date in the Litigation Area. Wells 2MG20, 2MG21, and 2MG22 were installed in 1987 as a part of the remedial investigation (RI) conducted by the U.S. Army Corps of Engineers, Waterways Experimentation Station (WES) (Lee and others 1988). These three wells were installed within a 100-foot radius of a rubble pile at the kiln site in RASS 2, a known source of soil contamination, to determine whether groundwater was affected by the soil contamination. A fourth well (3MG19) was installed about 1,500 feet south of the kiln site as a background well.

After reviewing the RI, RWQCB issued a tentative administrative order to the Navy, requesting a more detailed analysis of site groundwater. In response to this tentative order, WES identified 18 additional locations for monitoring wells in the Litigation Area. The additional wells were installed by IT in 1988. Locations of all Litigation Area monitoring wells are illustrated on Figures 67 and 68.

The monitoring wells have been sampled in four separate episodes since they were installed, as summarized below. Historical analytical results for each monitoring well are presented in Attachment E3. The first sampling episode occurred in May and August 1987. The four wells installed by WES were sampled for six metals (arsenic, cadmium, copper, lead, selenium, and zinc) as a part of the RI (Lee and

others 1988). Elevated concentrations of lead and zinc were detected in several wells. Both filtered and unfiltered metals samples were collected. Because unfiltered metals samples are influenced by turbidity levels, only filtered metals concentrations are reported in Attachment E3.

The second sampling episode was conducted by IT. Beginning in February 1989, all 22 wells in the Litigation Area were sampled quarterly for four quarters (IT 1993). For the first two quarters of sampling (February and May 1989), the wells were sampled for metals, VOCs, SVOCs, TOC, total dissolved solids (TDS), and major anions. Because the results from the first two quarters of sampling showed that VOCs and SVOCs were only rarely present in groundwater, VOCs and SVOCs were not analyzed in subsequent quarters.

The third sampling episode was conducted by ES. Beginning in March 1991, ES sampled all of the wells quarterly for metals for a period of eight quarters, ending in December 1992 (IT 1993). Following the quarterly sampling, ES sampled the wells on four other occasions (March 1993, June 1993, March 1994, and July 1994) to evaluate concentrations of metals in groundwater during and after soil remediation.

The fourth sampling episode occurred in October 1996 to assess postremediation groundwater concentrations. The wells were sampled using low-flow rate sampling techniques, where possible. Wells that could not sustain pumping rates of 0.1 L/min were purged dry, allowed to recharge overnight, and sampled the following day. Unfiltered groundwater samples were collected from both sets of wells. The October 1996 groundwater sampling event is described in detail in the "Tidal Influence Study and Postremediation Groundwater Monitoring Technical Memorandum" (TtEMI 1997).

Historical analytical results for each monitoring well are presented in Attachment E3. Data in Attachment E3 show that metals concentrations in groundwater in the Litigation Area dropped significantly following the removal of contaminated soil. For example, lead was ubiquitous in the preremediation groundwater samples but was not detected in any of the postremediation samples. Zinc was also ubiquitous in the historical samples but was detected only in well 2AG09 during postremediation sampling. Zinc concentrations in well 2AG09 dropped by about one order of magnitude following soil remediation. A similar pattern was noted for arsenic. Arsenic was detected in every well before soil remediation but was detected only in well 1AG04 following remediation, at a much lower concentration.

Although significant reductions in metals concentrations were generally observed following remediation, groundwater concentrations of some metals still exceeded AWQC. Postremediation concentrations of arsenic, cadmium, copper, selenium, and zinc exceeded AWQC in 1 to 5 of the 11 wells sampled. In most cases, the groundwater concentration of metals exceeded AWQC by a small amount; however, the

zinc concentration in well 2AG09 exceeded AWQC by a significant margin. Zinc was not detected in any other well. Detection limits for groundwater samples collected in 1996 did not exceed AWQC.

The 1996 groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and extractable and purgeable TPH. With the exception of motor oil-range hydrocarbons, organic compounds were not detected in groundwater in the Litigation Area in October 1996. This result was consistent with analytical results obtained in February and May 1989, where only common laboratory contaminants such as methylene chloride and acetone were detected (except for well 1PG18, where chlorinated solvents were detected at low estimated concentrations in 1989). Motor oil-range hydrocarbons were detected in all but 1 of the 11 wells sampled. In seven of these wells, the concentration was flagged with a "Z" qualifier, indicating that the chromatogram for the detected hydrocarbons did not match the expected pattern for a fuel. Hydrocarbons in these wells are probably naturally occurring hydrocarbons that are common in wetland areas. Hydrocarbons detected in wells 1AG04, 1PG18, and 3MG12 may be related to petroleum products, but concentrations were all less than 0.5 ppm, and potentially hazardous compounds associated with petroleum such as benzene and PAHs were not detected in the wells.

In summary, groundwater monitoring conducted in the Litigation Area demonstrated that groundwater has historically been contaminated with metals and that metals concentrations declined substantially following removal of metals-contaminated soils. Concentrations of selected metals in groundwater exceed AWQC in some wells in the Litigation Area marsh. Because groundwater flow rates are very slow, discharge to the slough, mosquito ditches, or subtidal discharge to Suisun Bay is expected to be very small (Section 7.3).

Motor oil-range hydrocarbons were detected in almost all of the wells sampled. For the most part, these hydrocarbons appear to be naturally occurring and do not appear to be related to petroleum hydrocarbon contamination. Hydrocarbons detected in wells 1AG04, 1PG18, and 3MG12 may be related to petroleum products, but concentrations are all less than 0.5 ppm. No other organic compounds were detected in groundwater.

Metals concentrations in groundwater that exceeded AWQC were not considered a major issue at the site because groundwater flow velocities are very slow and groundwater discharge to the sloughs and mosquito ditches and subtidal discharge along the shoreline is likely to be very small compared with the volume of flowing surface water. In addition, the high proportion of clay in the subsurface is expected to cause significant retardation, which would further slow the rate of metals transport and reduce concentrations that could discharge to a surface water body.

7.2.2 Off-site Groundwater Monitoring Data

Extensive groundwater monitoring has been conducted at the CPC facility and the GCC facility in conjunction with environmental investigations at these sites. CPC is southeast of the Litigation Area marsh and upgradient from Nichols Creek (Figure 48). The exact location of the CPC facility relative to the elongated groundwater high is difficult to assess because of a lack of potentiometric surface data and because the position of the high appears to shift over time. The location of the groundwater high is illustrated on Figures 67 and 68. Groundwater to the northeast of the elongated high will flow toward the northeast and then turn to the west and flow toward the Litigation Area. Groundwater to the southwest of the elongated high will flow to the southwest, toward Nichols Creek. In either situation, contaminated groundwater from the CPC facility is upgradient from Navy property

Groundwater monitoring data for the CPC facility is presented in Attachment E1 and show that groundwater at the CPC facility is contaminated with very high levels of zinc. For example, zinc was detected at a concentration of 2,900,000 µg/L (0.29 percent) in well V-4R in 1993 and at concentrations of approximately 50,000 µg/L in 1998 in four wells at the site, including two wells along the western fence line of CPC (M-2R and V-5), within 50 feet of Nichols Creek. Elevated concentrations of copper and lead (up to 110 and 36 µg/L) were also detected in samples collected in 1998 from CPC. The 1998 analytical results are the most recent results available. ES reports that a perched groundwater zone, consisting of 1 to 2 feet of fine sand underlain by several feet of saturated sandy or clayey silt, was present at a depth of approximately 30 feet below grade at CPC (ES 1987). This zone may be in hydraulic communication with Nichols Creek. The lithologies of the perched zone reported by ES were not identified on lithologic logs for the nearest Navy monitoring wells (3MG06, 3MG13, and 3MG14), suggesting that this zone does not extend far to the northwest from CPC.

GCC is directly east of RASS 1 and directly upgradient from the RASS 1 marsh (Figure 48). Analytical results from periodic groundwater monitoring at GCC are reported in Table E1-4. At GCC, high concentrations of aluminum (2,400,000 µg/L), arsenic (400,000 µg/L), copper (810 µg/L), mercury (2.5 µg/L), nickel (1,200 µg/L), selenium (140 µg/L), and zinc (4,700 µg/L) were detected (Attachment E1). In addition, chlorinated solvents and total petroleum hydrocarbons were detected at concentrations up to 310 µg/L at GCC.

In summary, the GCC and CPC facilities are directly upgradient from the Litigation Area marsh and Nichols Creek, and recent monitoring data from these sites show that groundwater at these sites is

contaminated with very high concentrations of the same metals that affect groundwater in the Litigation Area.

7.3 GROUNDWATER AND SURFACE WATER INTERACTION

Groundwater and surface water interaction in the Litigation Area marsh is expected to be minimal because the very low hydraulic conductivity of the silty clay that predominates the subsurface of the marsh does not transmit water well. Tidal fluctuations in surface water elevations are periodic, and tides are expected to cause surface water elevations to be higher than groundwater elevations during high tides and lower than groundwater elevations at low tides. As a result, the subsurface adjacent to surface water bodies experiences frequent reversals of hydraulic gradient, which will further inhibit discharge to surface water bodies.

Groundwater and surface water interaction was evaluated as part of a tidal influence study conducted in 1996, which is described in detail in the tidal influence technical memorandum (TtEMI 1997). Water levels and salinity were measured in five monitoring wells from three locations in Lost Slough and in the RASS 3 pond over a period of 6 days during the spring tide when the water level difference between high and low tides was most extreme and tidal effects would be expected to be greatest. No rainfall occurred for the duration of the test or during the previous month; therefore, precipitation did not contribute to water level variations in surface water and the wells.

In general, the surface water curves showed that water level variations are sinusoidal and that tides rise and fall more or less in synchrony throughout the slough. Surface water elevations at the mouth of Lost Slough varied by approximately 5 feet between high and low tides, and surface water levels in Lost Slough at the upper slough monitoring location varied by about 4.7 feet. Water level curves in the RASS 3 pond exhibited a different shape because of a restriction and an earthen embankment at the outlet to the pond.

Groundwater levels in three wells screened in the silty sand lens and two wells screened in the silty clay were monitored and compared with the surface water curves to ascertain tidal influence in the upper water-bearing zone. The water level curves for the wells screened in the silty sand lens showed that only well 3AG10 experienced significant variations in water level (0.2 foot) that correlate with surface water variations. The water level curve for 3AG10 closely tracked the water level curve for the pond and did not match the sinusoidal water level curve for the bridge location at the mouth of the slough. The bridge location is shown on Figure 68. The similarity of the water level curve for 3AG10 and the curve for the pond suggests that the pond is in hydraulic communication with the sand body in which well 3AG10 is

screened and that water level variations in the pond have a much greater influence on the sand body than variations in the nearby sloughs.

Two other wells (3MG11 and 4MG17) screened in the same sand lens experienced small tidally related fluctuations in water level. The magnitude of tidal variation in these wells was small (0.05 foot), but the wells exhibited discernible water level highs that coincide with water level highs at the bridge, indicating that water levels in the sand body respond to tidal variations in Suisun Bay or to the same celestial forces that cause the tides.

Water level variations in the wells screened in silty clay showed variable responses to the tides. The water level in one well (1AG02) did not respond to tidal variations in nearby surface water bodies. The water level curve for this well was flat and did not exhibit the sinusoidal variation in water level that would indicate tidal influence. The second well screened entirely in the silty clay (2AG09) exhibited significant variations in water level (0.4 foot) that correlate with the tides. This well is about 150 feet from the nearest mosquito ditch and experienced a water level variation of about one-tenth of the amplitude of the tidal variation in surface water.

The shape of the water level curve for well 2AG09 was intermediate between those of the bridge and pond monitoring stations, suggesting that silty clay in this area is influenced both by water variations in the pond and in the slough. Water level variations in the pond may be transmitted laterally through the subsurface sand body, which may be present in the subsurface near well 2AG09, although the well log for this well shows no silty sand. The water level highs in the well lag the highs in the slough mouth and the pond by about 5 and 3.5 hours, respectively, indicating that pressure pulses associated with the tides travel relatively slowly through the subsurface and that the pulses persist in the subsurface for periods of several hours.

Salinity was also monitored as part of the tidal influence study. Because of problems with the downhole monitoring instruments, salinity curves are only available for three of the wells (2AG09, 3AG10, and 4MG17). Salinities of groundwater in these wells were significantly lower than the measured salinities in the slough. Groundwater discharge to the sloughs would be expected to be greatest at low tide, when the maximum elevation difference exists between groundwater and surface water. As a result, low salinity groundwater would be expected to discharge into the sloughs at low tide, and overall salinity in the slough would be expected to decrease at low tide. However, the opposite occurs: at low tide, salinity in the slough begins to increase, rather than decrease. The fact that salinity of the slough increases at low tide, rather than decreases as would be expected if significant volumes of low salinity groundwater

discharged to the slough, indicates that groundwater does not discharge to the slough in sufficient volume to modify the salinity in the slough at low tide.

Groundwater and surface water samples were also collected during the tidal influence study and analyzed for stable isotopes of oxygen and hydrogen. The stable isotope ratios in groundwater and surface water samples from Suisun Bay and Lost Slough fall into two distinct categories, with no overlap between the two groups. These isotope data further suggest that limited interaction between groundwater and surface water occurs.

In summary, although no clear and decisive line of evidence exists indicating that groundwater and surface water are effectively isolated from each other in the marsh, the balance of evidence strongly suggests that groundwater and surface water interaction in the Litigation Area marsh is very limited. The evidence suggesting that groundwater and surface water interaction is limited includes:

- **Hydraulic conductivity and gradient reversals:** The hydraulic conductivity of silty clay that comprises the subsurface materials in the Litigation Area marsh has very low hydraulic conductivity, and does not transmit water well. The rising and falling tides cause frequent reversals of hydraulic gradient, and flow toward the ditches and slough during a low tide would reverse with a rising tide.

- **Salinity variations in the slough:** Groundwater had much lower salinity than surface water during the tidal influence study. If low salinity groundwater discharged to the slough, then salinity in the slough would be expected to drop at low tide. In fact, the opposite occurred.

- **Stable isotope ratios:** Stable isotope ratios for groundwater and surface water fall into two distinct categories. If significant mixing occurred, the two categories would be expected to overlap.

In upland areas, groundwater and surface water appear to be interconnected. The tidal influence study demonstrated that surface water level fluctuations in the RASS 3 pond correspond closely with groundwater level fluctuations in one well screened in the silty sand lens along the railroad tracks near the pond. A groundwater mound that roughly coincides with Nichols Creek and field observations that Nichols Creek was flowing in the area south of the railroad tracks and was dry north of the railroad tracks in October 2000 indicate that Nichols Creek is a losing creek during at least some parts of the year.

7.4 GROUNDWATER CLASSIFICATION

Groundwater at NWSSBD Concord has not been formally classified according to EPA or RWQCB guidelines, since groundwater is not currently a source of drinking water and is unlikely to be developed as a source because groundwater does not meet criteria for potable water sources. This section describes

the Navy's rationale for the preliminary assessment that groundwater at the Litigation Area is nonpotable, summarizes information collected from groundwater studies conducted at the Litigation Area, and presents an evaluation of groundwater as a potential source of drinking water.

EPA's "Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy" (EPA 1988) identify three classes of groundwater. Class I groundwater is ecologically vital or is an irreplaceable source of drinking water. Class II groundwater is a current or potential source of drinking water that has other beneficial uses. Class III groundwater is not a potential source of drinking water and is of limited beneficial use. EPA identifies Class III groundwater as exhibiting (1) a TDS concentration greater than 10,000 mg/L or (2) a well yield less than 150 gpd. The "San Francisco Bay Basin Water Quality Control Plan" (RWQCB 1995) defines groundwater with TDS concentrations exceeding 3,000 mg/L or sustained well yields of 200 gpd as unsuitable for municipal or domestic water supply. As a conservative approach, the Navy defines groundwater as nonpotable if it meets the more stringent of the two sets of requirements: TDS concentration is greater than 10,000 mg/L or well yields less than 150 gpd (0.39 liters per minute [L/min]).

Based on this definition, much or all of the groundwater in the Litigation Area is not considered a potential source of potable water. Attachment E3 of this document summarizes all analytical data collected to date from the 22 monitoring wells in the Litigation Area. The wells were analyzed for TDS during four consecutive quarterly sampling events in 1989. Concentrations detected exceeding the standard were considered consistent if three of the four quarterly measurements exceeded 10,000 mg/L. Based on this criterion, eight wells in the Litigation Area marsh are considered nonpotable. These wells are identified in Table 26.

Sustainable well yield was assessed by evaluating lithology and records from low flow rate sampling conducted in 1996. In the 1996 sampling event, 11 monitoring wells were sampled using low flow rate techniques. Water level and discharge from the well was recorded periodically during the low flow rate purging. The purging rate was calculated by dividing volume discharged by elapsed time. monitoring well sampling sheets included as Appendix B to the postremediation groundwater sampling technical memorandum (TtEMI 1997) show that 5 of the 11 wells sampled were unable to sustain a 0.1 L/min purge rate, and would be unable to sustain a withdrawal rate of 0.39 L/min. These wells are identified in Table 26. Two of the remaining six wells (1AG02 and 1PG05) drew down more than 0.5 foot in 1 to 1.5 hours, with a purge rate of 0.22 to 0.25 L/min. It is unlikely that these wells could withstand a continuous long-term pump rate of 0.39 L/min without a much more significant drawdown.

Well logs for each of the 22 monitoring wells in the Litigation Area are included with this document as Attachment E4. Review of these logs show that the lithology over much of the Litigation Area consists almost exclusively of silt and clay sized particles. It is unlikely that a water supply well would be screened in silts and clays because these materials exhibit low hydraulic conductivities and are not typically considered water-bearing units for water supply purposes. The well logs show that the only locations in the Litigation Area where silty sand intervals are noted are 2MG20, and 2MG21, 2MG22; 3MG13, 3MG14, and 3MG19; and 4MG15, 4MG16, and 4MG17. Of these, wells 4MG15 and 4MG16 were shown to be unable to sustain a 0.1 L/min purge rate. The lithologic log for well 4MG17 is very similar to that of 4MG16; therefore, this well is expected to exhibit similar inability to recharge.

Six wells in two areas within the Litigation Area could meet the conservative definition of potability: a small area surrounding wells 2MG20 through 2MG22, and a larger area in the southwestern corner of the Litigation Area, west of Nichols Creek (wells 3MG14 and 3MG19). Locations of these wells are shown on Figures 67 and 68. Several wells in these two areas did not exhibit high TDS and can sustain low pumping rates, but are screened in discontinuous 3- to 5-foot-thick silty sand lenses. Cross-sections contained in the postremediation groundwater monitoring technical memorandum (TtEMI 1997) illustrate that these silty sand lenses are surrounded by wells that did not penetrate sandy units and have limited lateral extent. In the Navy's professional judgment, water supply wells screened in these silty sand lenses would be unable to sustain pump rates of 150 gpd in the long term because these silty sand lenses contain limited quantities of water. In addition, wells producing water from these silty sand lenses would exhaust the water supplies contained within the lenses and would begin to draw in water with high TDS concentrations from adjacent areas. As a result, the balance of evidence suggests that groundwater in the Litigation Area is not suitable for potable water supply.

In summary, groundwater that meets a conservative interpretation of EPA and RWQCB definitions of potability would exhibit TDS concentrations less than 10,000 mg/L or well yields less than 150 gpd (0.39 L/min). Groundwater data collected from the Litigation Area monitoring wells indicate that the wells in RASS 1 have TDS concentrations greater than 10,000 mg/L, and would not be considered potable. Most wells in the upland areas outside of the Litigation Area marsh were screened in silty clay formations that cannot sustain a well yield of 0.1 L/ minute. Some wells were screened in silty sand or sand that produced water with TDS concentrations below 10,000 mg/L and appear to be able to sustain a yield of 150 gpd in the short term. However, these wells are screened in sand lenses with limited extent; therefore, prolonged pumping from these wells would eventually dewater the sand lenses. These wells are not believed to be capable of sustaining a yield of 150 gpd for the long term. Based on this rationale, groundwater in the Litigation Area is not considered potable.

7.5 LITIGATION AREA GROUNDWATER CONCLUSIONS

The following conclusions can be drawn from the groundwater studies and sampling that have been conducted to date in the Litigation Area:

- Groundwater in the Litigation Area marsh generally flows to the north or northwest toward the tidal wetlands. An elongated groundwater mound roughly coincides with Nichols Creek, which directs groundwater flow toward the southwest in the southwest corner of the site. The exact position of this groundwater high is difficult to assess with the given data, and the position of the high appears to shift slightly over time.

- A maximum seepage velocity of 0.7 meter per year (2.3 feet per year) is estimated for silty clay that underlies the marsh. Because gradients in the Litigation Area marsh are expected to be lower than the maximum of 0.008 and the high proportion of clay in the subsurface is expected to cause significant retardation, actual flow velocities and contaminant migration velocities are likely to be much lower. The wells are approximately 2,000 feet from the shoreline of Suisun Bay and 150 feet from the nearest ditch; therefore, any contamination detected in the monitoring wells would take a minimum of 870 years to reach the shoreline of Suisun Bay or a minimum of 65 years to reach the nearest mosquito ditch.

- Groundwater monitoring conducted in the Litigation Area demonstrates that groundwater has historically been contaminated with metals and that metals concentrations declined substantially following removal of metals-contaminated soils. Concentrations of selected metals in groundwater exceed AWQC in some wells in the Litigation Area marsh. Metals concentrations in groundwater that exceed AWQC have not been considered a major issue at the site because groundwater flow velocities are very slow and groundwater discharge to the sloughs, mosquito ditches, and subtidal discharge along the shoreline is likely to be very small relative to the volume of flowing surface water.

- Motor oil-range hydrocarbons were detected in almost all of the wells sampled. Chromatograms of these hydrocarbons do not match the expected chromatograms for petroleum fuels; therefore, these hydrocarbons appear to be naturally occurring marsh hydrocarbons and do not appear to be related to petroleum hydrocarbon contamination. Hydrocarbons detected in selected wells may be related to petroleum products, but concentrations are typically low (less than 0.5 mg/L). No other organic compounds were detected in groundwater.

- The GCC and CPC facilities are directly upgradient from the Litigation Area marsh and Nichols Creek, and recent monitoring data from these sites show that groundwater at these sites is contaminated with very high concentrations of the same metals that affect groundwater in the Litigation Area.

- CPC is southeast of the Litigation Area marsh and upgradient from Nichols Creek. Groundwater at the CPC facility is contaminated with very high levels of zinc. For example, zinc was detected at a concentration of 2,900,000 µg/L (0.29 percent) in well V-4R in 1993, and at concentrations exceeding 50,000 µg/L in wells along the western fenceline of CPC, within 50 feet of Nichols Creek.

- GCC is directly east of RASS 1 and directly upgradient from the Litigation Area marsh. High concentrations of aluminum (2,400,000 µg/L), arsenic (400,000 µg/L), copper (810 µg/L), mercury (2.5 µg/L), nickel (1,200 µg/L), selenium (140 µg/L), and zinc (4,700 µg/L) were detected at GCC. In addition, chlorinated solvents and total petroleum hydrocarbons were detected at concentrations up to 310 µg/L.

- Although lacking decisive information, the balance of evidence strongly suggests that groundwater and surface water interaction in the Litigation Area marsh is very limited. In upland areas, groundwater and surface water in Nichols Creek and the RASS 3 pond appear to be interconnected.

- Groundwater in the Litigation Area has not been formally classified, but would likely be considered nonpotable because (1) wells in the Litigation Area marsh exhibited TDS concentrations greater than 10,000 mg/L and (2) most wells are screened in a silty clay formation that cannot sustain a yield of 150 gpd. Some wells screened in a silty sand lens have TDS concentrations below 10,000 mg/L and may be able to yield 150 gpd of groundwater. However, the sand lens has limited aerial extent and prolonged pumping of wells screened in this lens would dewater the lens. Wells screened in the sand lens are not expected to be capable of sustaining pumping rates of 150 gpd in the long term.

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ATTACHMENT E1

SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SOIL AT CHEMICAL AND PIGMENT COMPANY AND GENERAL CHEMICAL CORPORATION FACILITIES

TABLE E1-1

CHEMICAL CONCENTRATIONS IN GROUNDWATER AT CHEMICAL AND PIGMENT COMPANY

Well Number	Date Sampled	Zinc (µg/L)	Copper (µg/L)	Lead (µg/L)
M-1	4/92	<50	<10	NA
	7/92	53	<10	NA
	10/92	110	<10	<5
	1/93	<20	<10	<5
	4/93	<20	<10	<5
	7/93	48	<10	<5
	10/93	<20	<10	<5
	1/94	<50	<10	<5
	4/94	53	11	<5
	10/94	110	<10	<5
	4/95	41	<10	<5
	10/95	70	<25	<4
	4/96	23	<25	<4
	10/96	170	<25	<4
	4/97	150	<25	<4
	4/98	28	<10	<5
M-2R	4/92	<50	<10	NA
	7/92	56	<10	NA
	10/92	62	<10	<5
	4/93	2,800	<10	21
	7/93	<20	<10	12
	10/93	<20	<10	<5
	1/94	<50	<10	<5
	4/94	29	<10	<5
	10/94	<20	<10	<5
	4/95	<20	<10	<5
	10/95	20	<25	<4
	4/96	82	<25	<4
	10/96	4,500	<25	<4
	4/97	88,000	<25	18
	4/98	55,000	<10	36

TABLE E1-1 (Continued)

CHEMICAL CONCENTRATIONS IN GROUNDWATER AT CHEMICAL AND PIGMENT COMPANY

Well Number	Date Sampled	Zinc (µg/L)	Copper (µg/L)	Lead (µg/L)
M-3R	4/92	17,000	23	**NA**
	7/92	42,000	170	**NA**
	10/92	22,000	64	510
	1/93	22,000	71	500
	4/93	28,000	68	250
	7/93	18,000	<10	38
	10/93	13,000	<10	<5
	4/94	8,700	<10	<5
	10/94	8,100	<10	<5
	4/95	7,400	<10	<5
	10/95	7,800	<25	<4
	4/96	8,000	<25	<4
	10/96	5,600	<25	<4
	4/97	6,400	<25	<4
	4/98	7,600	<10	<5
M-4	4/92	12,000	12	NA
	7/92	11,000	14	NA
	10/92	12,000	17	<5
	1/93	6,500	<10	NS
	4/93	2,800	<10	<5
	7/93	3,700	<10	<5
	10/93	480	<10	<5
	1/94	160	<10	<5
	4/94	90	<10	<5
	10/94	82	<10	<5
	4/95	160	<10	<5
	10/95	54	<25	<4
	4/96	62	<25	<4
	10/96	27	<25	<4
	4/97	28	<25	<4
	4/98	140	<10	<5

TABLE E1-1 (Continued)

CHEMICAL CONCENTRATIONS IN GROUNDWATER AT CHEMICAL AND PIGMENT COMPANY

Well Number	Date Sampled	Zinc (µg/L)	Copper (µg/L)	Lead (µg/L)
M-5	4/92	<50	<10	NA
	7/92	450	11	NA
	10/92	93	<10	<5
	1/93	NS	NS	NS
	4/93	52	<10	<5
	7/93	64	<10	<5
	10/93	55	<10	<5
	1/94	82	<10	<5
	4/94	70	<10	<5
	10/94	67	<10	<5
	4/95	50	<10	<5
	10/95	33	<25	<4
	4/96	48	<25	<4
	10/96	43	<25	<4
	4/97	96	<25	<4
	4/98	54	<10	<5
M-6	4/92	64,000	<10	NA
	7/92	65,000	15	NA
	10/92	68,000	12	28
	1/93	82,000	<10	<5
	4/93	39,000	<10	<5
	7/93	46,000	<10	<5
	10/93	27,000	<10	<5
	1/94	17,000	<10	<5
	4/94	18,000	<10	<5
	10/94	14,000	<10	<5
	4/95	12,000	<10	<5
	10/95	18,000	<25	<4
	4/96	17,000	<25	<4
	10/96	12,000	<25	<4
	4/97	11,000	<25	<4
	4/98	850	<10	5.2

TABLE E1-1 (Continued)

CHEMICAL CONCENTRATIONS IN GROUNDWATER AT CHEMICAL AND PIGMENT COMPANY

Well Number	Date Sampled	Zinc (µg/L)	Copper (µg/L)	Lead (µg/L)
M-7	4/92	120	<10	<5
	7/93	<20	<10	<5
	10/93	<20	<10	<5
	1/94	<50	<10	<5
	4/94	21	<10	<5
	10/94	74	<10	<5
	4/95	220	<10	<5
	10/95	110	<25	<4
	4/96	41	<25	<4
	10/96	63	<25	<4
	4/97	190	<25	<4
	4/98	600	<10	<5
M-8	4/92	<20	<10	<5
	7/93	58	<10	<5
	10/93	170	<10	<5
	1/94	130	<10	<5
	4/94	110	<10	<5
	10/94	91	<10	<5
	4/95	510	<10	<5
	10/95	350	<25	<4
	4/96	18,000	<25	<4
	10/96	140	<25	<4
	4/97	130	<25	<4
	4/98	540	<10	10
V-1	10/92	140,000	<10	16
	1/94	170,000	<10	<5
	10/95	110,000	<120	<4
	4/96	290	<25	<4
	10/96	76,000	<25	<4
	4/97	150,000	<25	<4
	4/98	83,000	<10	<5

TABLE E1-1 (Continued)

CHEMICAL CONCENTRATIONS IN GROUNDWATER AT CHEMICAL AND PIGMENT COMPANY

Well Number	Date Sampled	Zinc (µg/L)	Copper (µg/L)	Lead (µg/L)
V-4R	4/92	140,000	470	NA
	1/93	2,900,000	42	9
	4/93	1,500,000	370	24
	7/93	1,400,000	210	120
V-5	4/92	20,000	7	NA
	1/93	130,000	<10	<5
	4/93	49,000	<10	<5
	4/95	140,000	<10	<5
	4/97	150,000	<25	<4
	4/98	49,000	<10	<5
V-6	4/92	890,000	280	NA
	1/93	1,200,000	71	<5
	4/93	1,200,000	380	8
	7/93	1,500,000	160	200
	4/94	360,000	130	10
	4/95	1,400,000	290	<5
	10/95	1,400,000	<1,200	4.1
	4/96	1,000,000	<250	<4
	4/97	1,100,000	99	<4
	4/98	1,100,000	110	<5
V-8	4/98	1,500	<10	<5

Notes:

CPC Chemical and Pigment Company
µg/L Microgram per liter
NA Not analyzed

Location of CPC wells shown on Figure 48 in the five-year review report.

Source:

Cooper, White, and Cooper LLP. 1999. Letter Regarding Chemical Concentrations in Groundwater at Chemical and Pigment Company. From Keith Howard, Cooper White, & Cooper, to Ralph Lee, Site Environmental Office, Naval Weapons Station, Seal Beach Detachment Concord. May 10.

TABLE E1-2

CHEMICAL CONCENTRATIONS IN SOIL AT CHEMICAL AND PIGMENT COMPANY

Borehole	Depth	Date Sampled	Zinc (mg/kg)	Copper (mg/kg)	Lead (mg/kg)
M-4	10	10/15/87	59,800	584	NA
	25	10/15/87	11,200	9.9	NA
	25	10/15/87	10,000	13	NA
	30	10/15/87	21.5	9.0	NA
	40	10/15/87	45.5	16.5	NA
	45	10/15/87	91.2	18.2	15.7
M-5	10	10/14/87	30.0	7.2	NA
	50	10/14/87	25.4	4.3	1.3
V-1	15	10/13/87	27.3	9.8	NA
	25	10/13/87	64	NA	NA
	30	10/13/87	20.9	8.5	4.7
V-2	10	10/13/87	8,940	10.7	NA
	25	10/13/87	37.1	NA	NA
	30	10/13/87	29.9	11.4	4.1
V-3	10	10/12/87	500	10.1	NA
	17.5	10/12/87	2,890	NA	NA
	25	10/12/87	24.6	NA	NA
	30	10/12/87	20.1	7.4	3.0
V-4	10	10/13/87	4,730	12.5	NA
	25	10/13/87	3,800	17.4	NA
	30	10/13/87	16,800	9.5	3.1

Notes:

mg/kg Milligram per kilogram
NA Not available

Source:

Environmental Solutions, Inc. 1987. "Hydrogeological Assessment Report for an Impoundment at 600 Nichols Road, Pittsburg, California." Prepared for Chemical and Pigment Co., Pittsburg, California. December 31.

TABLE E1-3

CHEMICAL CONCENTRATIONS IN SOIL BENEATH THE SURFACE IMPOUNDMENT AT CHEMICAL AND PIGMENT COMPANY

Test Pit	Depth (feet)	Zinc (mg/kg)	Copper (mg/kg)	Cadmium (mg/kg)	Lead (mg/kg)	pH
1	1	1,200	140	4.9	540	5.4
	3	21,000	12	12	ND	5.4
	5	10,000	14	8.2	ND	5.8
2	1	9,900	15	6.8	ND	5.9
	3	6,100	58	1.7	20	6.1
	5	5,300	15	1.8	ND	5.9
3	1	11,000	14	6.6	ND	5
	3	11,000	13	35	ND	5.6
	5	5,900	14	ND	ND	7.1
4	1	49,000	1,000	23	ND	6.6
	3	7,800	16	2.8	60	6.1
	5	12,000	19	2.8	37	5.7
5	1	6,700	68	3.5	54	6.1
	3	23,000	15	4.5	ND	6
	5	16,000	13	5.5	ND	5.9
6	1	16,000	23	2.9	170	6.2
	3	10,000	37	2.8	110	5.6
	5	13,000	64	9	53	5.8
7	1	11,000	15	2.2	ND	6.2
	3	11,000	15	4.4	22	6.7
	5	7,700	13	5.8	ND	5.8
8	1	15,000	23	ND	27	12
	3	17,000	18	6.2	ND	12
	5	630	15	ND	ND	11

Notes:

mg/kg Milligrams per kilogram
NA Not available

Source:

The Mark Group. 1990. "Field Sampling and Analysis of Vertical Extent of Metals Containing Soils beneath the Surface Impoundment, CPC." November.

TABLE E1-4

SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AT GENERAL CHEMICAL CORPORATION'S AREA OF CONCERN 1

Compound	Maximum Detected (µg/L)	Location and Date of Sampling	Frequency of Detection	Number of Samples
Metals				
Aluminum	2,400,000	MW-S10, 9/2/98	10/13	13
Antimony	38	MW-S03, 9/1/98	2/13	13
Arsenic	400,000	MW-S14, 9/1/98	12/13	13
Barium	75	MW-S14, 9/1/98	8/13	13
Beryllium	34	MW-S02, 9/2/98	2/13	13
Cadmium	550	MW-S08, 9/2/98	3/13	13
Chromium	270	MW-S02, 9/2/98	3/13	13
Cobalt	400	MW-S02, 9/2/98	7/13	13
Copper	810	MW-S05, 9/2/98	7/13	13
Lead	5.3	MW-S05, 9/2/98	2/13	13
Mercury	2.5	MW-S11, 9/3/98	3/13	13
Molybdenum	56	MW-S09, 9/2/98	5/13	13
Nickel	1,200	MW-S02, 9/2/98	8/13	13
Selenium	140	MW-S03, 9/1/98	9/13	13
Thallium	5.7	MW-S05, 9/2/98	1/13	13
Vanadium	260	MW-S10, 9/2/98	6/13	13
Zinc	4700	MW-S08, 9/2/98	13/13	13
Volatile Organic Compounds				
1,1-Dichloroethane	28	MW-S12, 9/2/98	2/13	13
1,1-Dichloroethene	11	MW-S12, 9/2/98	1/13	13
1,2-Dichlorbenzene	34	MW-S12, 9/2/98	1/9	13
1,4'-Dicholorobenzene	4.1	MW-S12, 9/2/98	1/9	13
Acetone	130	MW-S03, 9/1/98	6/13	13
Benzene	4.6	MW-S12, 9/2/98	1/13	13
Carbon disulfide	12	MW-S03, 9/1/98	2/13	13
cis-1,2-Dichloroethene	41	MW-S12, 9/2/98	1/13	13
Tetrachloroethene	12	MW-S12, 9/2/98	2/13	13
Total xylenes	5	MW-S12, 9/2/98	1/13	13
Trichlorethene	310	MW-S12, 9/2/98	1/13	13
Trichlorofluoromethane	70	MW-S11, 9/2/98	1/13	13

TABLE E1-4 (Continued)

SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AT GENERAL CHEMICAL CORPORATION'S AREA OF CONCERN 1

Compound	Maximum Detected (µg/L)	Location and Date of Sampling	Frequency of Detection	Number of Samples
Pesticides				
gamma-BHC	0.15	MW-S12, 9/2/98	1/13	3
delta-BHC	0.89	MW-S12, 9/2/98	1/13	3
BTEX and TPH				
Benzene	5.7	MW-S12, 9/2/98	3/13	13
Toluene	7.7	MW-S03, 9/1/98	2/13	13
TPH (as gasoline)	340	MW-S12, 9/2/98	5/13	13
Xylenes (total)	11	MW-S03, 9/1/98	7/13	13

Notes:

BHC Benzene hexachloride (formerly hexachlorocyclohexane)
BTEX Benzene, toluene, ethylbenzene, and xylenes
µg/L Micrograms per liter
TPH Total petroleum hydrocarbons

TABLE E1-5

SUMMARY OF CHEMICALS DETECTED IN SOIL AT GENERAL CHEMICAL CORPORATION'S AREA OF CONCERN 1

Compound	Maximum Detected (mg/kg)	Location and Depth of Maximum Detection (in feet bgs)	Frequency of Detection (number of detects/ total samples)
Metals			
Aluminum	31,000	AOC1-20, 2.25	83/85
Antimony	66.0	AOC1-10, 3.25	5/46
Arsenic	12,000	AOC1-10, 3.25	89/93
Barium	66,000	AOC1-02, 5.25	42/46
Beryllium	0.610	AOC1-04, 5.25	4/46
Cadmium	210	MW-S08, 5.5	14/46
Chromium	75	AOC1-05, 2.75	69/73
Chromium (Hexavalent)	4.4	AOC1-07, 1.25	7/71
Cobalt	25	AOC1-11, 2.75	28/46
Copper	32,000	AOC1-09, 2.75	46/46
Lead	48,000	AOC1-10, 3.25	72/93
Mercury	330	AOC1-10, 3.25	25/46
Nickel	47	AOC1-12, 2.25	38/46
Selenium	6400	AOC1-10, 3.25	11/46
Silver	29	AOC1-10, 3.25	7/46
Thallium	66	AOC1-09, 1.75	9/46
Vanadium	63	AOC1-05, 27.5	44/46
Zinc	3,700	AOC1-22, 2.25	46/46
Volatile Organic Compounds			
1,1-DCA	0.0430	SM10-01, 2.5	1/33
2-Butanone	0.04700	SM01-03, 5.0	4/29
Acetone	110.00	SM05-01, 2.5	12/29
Carbon disulfide	0.0220	AOC1-06, 1.25	4/29
Ethylbenzene	3.200	SM05-01, 2.5	2/29
Methylene chloride	0.0130	ACO1-13, 2.75; AOC1-13, 4.75	7/33
Xylene (total)	47.00	SM05-01, 2.5	2/29
BTEX and TPH			
Benzene	0.019	MW-S10, 1.5	1/5
Ethylbenzene	0.041	AOC1-06, 2.75	2/5
Toluene	0.016	AOC1-06, 2.75	4/5
TPH (as gasoline)	98.00	AOC1-06, 2.75	2/5
Xylenes (total)	0.700	AOC1-06, 2.75	4/5

TABLE E1-5 (Continued)

SUMMARY OF CHEMICALS DETECTED IN SOIL AT GENERAL CHEMICAL CORPORATION'S AREA OF CONCERN 1

Compound	Maximum Detected (mg/kg)	Location and Depth of Maximum Detection (in feet bgs)	Frequency of Detection (number of detects/ total samples)
PCBs/Pesticides			
4,4'-DDT	0.190	AOC1-20, 2.25; MW-S14, 1.75	5/16
Endosulfan II	0.038	AOC1-21, 2.75	1/16
PCB-1254	0.390	AOC1-20, 2.25	1/16

Notes

AOC Area of concern
bgs foot below ground surface
BTEX Benzene, toluene, ethylbenzene, and xylenes
DCA Dichloroethane
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl

ATTACHMENT E2

HISTORICAL TIMELINES OF THE CHEMICAL AND PIGMENT COMPANY AND GENERAL CHEMICAL CORPORATION FACILITIES

TABLE E2-1

CHEMICAL AND PIGMENT COMPANY HISTORICAL TIMELINE

Date	Event
1962	Chemical and Pigment Company (CPC) constructed to recover zinc from galvanizing waste to produce zinc chloride.
1965	CPC begins manufacturing various copper-and zinc-based chemicals. Zinc waste dumping on the westerly property line was terminated (California Department of Health Services [DHS] 1980).
1967	Zinc waste dumping on property south of the plant terminated (DHS 1980).
February 1969	CPC ceases the manufacture of copper sulphates for fungicide sprays.
March 17, 1969	Criminal complaint filed for unlawful disposal in waterways; $200 penalty paid on November 19, 1969 (DHS 1980).
December 9, 1969	As a result of conviction for unlawful disposal, tailing piles were removed, drainage sumps were enlarged, and storage facilities were improved.
1970	California Regional Water Quality Control Board (RWQCB) samples Nichols creek water. Water is toxic to fish (100 percent mortality), and a second complaint is filed.
1973	On-site disposal is eliminated.
March 10, 1975	RWQCB detected toxic levels of copper and zinc in soil.
March 14, 1975	RWQCB advised the CPC lawyer that some soils should be removed in the area adjoining the railroad tracks and in the open field south of the plant.
1975	CPC excavates some site soil, paves some working areas, and installs a retaining wall and sump drainage system to new holding pond.
1978	CPC states that all hazardous wastes have been shipped off site. CPC request for variance on their hazardous waste permit is granted (DHS 1980).
1978	Current impoundment engineered and constructed at CPC, as ordered by RWQCB Order No. 90-138.
August 5, 1980	RWQCB adopts Waste Discharge Order No. 80-38 for new 1.4–million-gallon pond to collect surface water runoff.
October 1980	DHS samples soil on the western border of CPC, along the edge of Nichols Creek. Results indicated elevated levels of cadmium (18 to 85 parts per million [ppm]), copper (2,200 ppm), lead (2,470 ppm), and zinc (2,500 to 14,000 ppm) (U.S. Environmental Protection Agency [EPA] 1985).
January 10, 1981	RWQCB sampling reveals high zinc concentrations near Nichols Creek; elevated concentrations of lead, copper, barium, and cadmium are also detected (EPA 1985).
April 6, 1982	RWQCB indicated that Nichols Creek is contaminated by either surface overflow or pond leakage (RWQCB 1982).
October 18, 1983	Report of monitoring well installation and embankment stability evaluation prepared by Klenfelder and Associates in compliance with request from RWQCB (as cited in Groundwater Technology, Inc. [GTI] 1992).
1986	RWQCB requests that CPC prepare a hydrogeological assessment report and close or retrofit the impoundment (GTI 1992).
1987	CPC provides plans for compliance; plans are approved by RWQCB.

TABLE E2-1 (Continued)

CHEMICAL AND PIGMENT COMPANY HISTORICAL TIMELINE

Date	Event
December 31, 1987	Hydrogeological assessment report for CPC submitted; was approved by RWQCB.
1989	Discharges to the impoundment, except for rainwater, are stopped (The Mark Group 1991).
December 1989	Zinc sludges excavated from the impoundment and a liner installed over the entire impoundment (The Mark Group 1991).
October 17, 1990	RWQB files Cease and Desist Order No. 90-138, requiring CPC to cease discharge to, and temporarily cover, the impoundment. The order cites zinc contamination at the site.
November 9, 1990	The Mark Group publishes a report of field sampling and analysis of vertical extent of metals containing soils beneath the surface impoundment at CPC. Results indicate the presence of elevated zinc concentrations below the impoundment (The Mark Group 1990).
1990	A polyethylene liner was added to the surface impoundment to prevent infiltration of contaminants.
January 25, 1991	CPC submits a closure plan for the surface impoundment (The Mark Group 1991).
August 26, 1991	RWQCB writes a letter describing the deficiencies of the closure plan.
May 14, 1992	CPC publishes a revised facility closure plan (by GTI)
November 25, 1992	The Mark Group submits a revised surface impoundment closure plan to RWQCB.
1992	A second polyethylene liner was added to the surface impoundment and a sodium hydroxide solution is added to raise the pH (GTI 1992).
November 4 1994	California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) publishes a compliance evaluation inspection report for CPC based on a site visit and laboratory analysis of site materials (DTSC 1994).
June 22, 1995	DTSC publishes CPC inspection report; report contains analytical results for total metals; all results for volatile organic compounds (VOC) were nondetect; chemicals of concern are cadmium, copper, lead, and zinc.
July 20, 1995	DTSC publishes investigation that confirms allegations that CPC was unlawfully accepting and disposing of hazardous waste (high levels of cadmium, lead, and zinc). DTSC recommends that the case not be prosecuted (due to age of owner), and be refereed for the Statewide Compliance Division for civil or administrative enforcement action.
November 18, 1996	Surface impoundment closure report submitted by CPC.
February 19, 1997	RWQCB approval of surface impoundment closure report; CPC removed sludge and existing impoundment liquids (storm water), compacted in-place wastes, backfilled the impoundment and compaction, and placed a semi-impermeable clay mat, liner, drain pipe, and top soil at the site.
September to October 1997	Operations were temporarily shut down.
Late 1997	CPC owner dies; company in severe financial stress.
March 1, 1998	CPC files Chapter 11 bankruptcy.

TABLE E2-1 (Continued)

CHEMICAL AND PIGMENT COMPANY HISTORICAL TIMELINE

Date	Event
April 1998	Fluor Daniel samples groundwater on site.
March 16, 1998	RWQCB issued an order against CPC (DTSC 1999).
December 30, 1998	Geomatrix Consultants (Geomatrix) transmits closure plan for 12,500–cubic-yard soil stockpile at site to RWQCB.
February 24, 1999	Soil characterization report for soil stockpile at CPC produced (Geomatrix 1999a).
March 5, 1999	DTSC issued Notice of Deficiency on December 1998 closure plan.
March 6, 1999	CPC ceases operations.
June 8, 1999	DTSC withdraws standardized hazardous waste facility permit for the site.
November 8, 1999	Closure plan submitted by Geomatrix.
November 23, 1999	Letter from DTSC outlining immediate corrective action measures required.
December 3, 1999	Letter from Cooper, White, and Cooper, LLP (CWC) in response to DTSC corrective action letter (CWC 1999b).
Winter 1999	Liquid wastes were removed from sumps and selected tanks.
March 9, 2000	Letter from DTSC to CPC concluding that corrective action measures proposed by Geomatrix are inadequate; hazardous wastes are still at the site (DTSC 2000b).
March 10, 2000	Letter from CWC to DTSC explaining bankruptcy transition from Chapter 11 to Chapter 7 (CWC 2000).
March 15, 2000	Letter from DTSC to CWC about removal of hazardous waste at CPC (DTSC 2000c).
July 10, 2000	DTSC requests a transfer of CPC to EPA for Comprehensive Environmental Response, Compensation, and Liability Act remedial action.

TABLE E2-2

GENERAL CHEMICAL COMPANY HISTORICAL TIMELINE

Date	Event
1905	Nichols Chemical Plant begins operations on 140-acre site in Pittsburg, California. Pyrite ore was burned to produce large volumes of low-grade sulfuric acid from off-gas.
1907	Nichols Chemical built a chemical manufacturing facility on site for production of sulfuric acid, nitric acid, and aluminum sulfate.
1920	Nichols Chemical changes name to Allied Chemical Corporation; later the name changed to Allied Signal (unspecified date).
1950	HF acid was added to production at facility.
Mid 1950s	On-site disposal of solid waste streams is speculated by DTSC to have been the primary solid waste management method. Process wastewater was reportedly discharged directly into a horseshoe-shaped lagoon that discharged into Suisun Bay.
Early 1960s	University of California Berkeley sampled discharge effluent for heavy metals and fluoride; discharges of gross heavy metals and fluoride were calculated to be 360 and 180 lbs per day.
1965	CP processes added to produce high purity acids for the electronics industry.
August 27, 1969	Harding Lawson Associates (HLA) published a soil investigation of proposed discharge facilities.
1970s	Process wastewater subject to in-line pH adjustment before discharge into the lagoon.
1972	Two polyethylene-lined evaporation ponds were constructed to receive effluents from alum production.
April 2, 1973	HLA published a soil investigation report of the exit stand, support stack, and tank car repair building (GTI 1995).
April 24, 1973	A pipe beneath a concrete pad in the HF plant area began leaking 300 gallons per hour of HF acid into the marshland southeast of the site. The plant was ordered to pump contaminated water into their wastewater treatment system and to relocate the top 18 inches of contaminated soils to an on-site area that drains into the wastewater treatment system (EPA 1984).
March 26, 1974	EPA issued a Finding of Violation regarding failure to comply with the National Pollutant Discharge Elimination System (NPDES) permit. Repeated violations of discharge limitations for ammonia, pH, and settleable matter were cited (EPA 1984).
August 4, 1974	HLA published a permeability study for the site (as cited in GTI 1995).
September 13, 1974	HLA published a soil investigation report of the proposed warehouse building (as cited in GTI 1995).
1975	An out-of-court settlement was reached regarding the Finding of Violation. Allied Signal agreed to implement additional engineering controls to further limit pollutant discharges (EPA 1984).
October 27 and 28, 1975	Effluent discharge limitations for arsenic were exceeded because of a collapsed sewer main where arsenic was leaching from underground residues. The pipe was repaired; however, no soils were removed (EPA 1984).

TABLE E2-2 (Continued)

GENERAL CHEMICAL COMPANY HISTORICAL TIMELINE

Date	Event
October 14, 1976	CDFG cited Allied Chemical Corporation for low pH runoff from land north and east of the old alum pond (EPA 1984).
April 12, 1977	Dikes were placed around the old alum pond to contain runoff.
May 24, 1977	HLA published a soil and geological investigation report of the Bay Point Works facility (as cited in GTI 1995).
February 19, 1979	The effluent limitation for fluoride was exceeded. The cause may have been groundwater leaching from adjacent soils into the U-shaped treatment lagoon. No studies or remedial actions resulted from this discharge (EPA 1984).
April 12, 1979	A RWQCB report stated that the zinc runoff problem, resulting in effluent limitation violations, could be solved by paving the "highly contaminated" area around the warehouse (EPA 1984).
1981	Allied Chemical Corporation changes name to Allied Signal.
1981	Allied Signal shut down and dismantled the sulfuric acid plants.
1981	DHS determined that alum sludge was nonhazardous.
1982	HLA published a soil and geologic study for the site (as cited in GTI 1995).
1984	Allied Signal shut down and dismantled hydrofluoric acid plants.
1986	Allied Signal sold the major manufacturing portion of the facility to GCC (26 acres).
1987	Lagoon sediment sampling for evaluation of compliance requirements with the Toxic Pits Control Act (TPCA); RWQCB determined that the facility was not subject to TPCA based on sediment bioassay results of 100 percent survival.
1991	Lagoon effluent dispersion study in Suisun Bay; results showed that the dilution ratio for permitted water discharge to Suisun Bay was more than the required 10:1 (IT 1999a, 1991).
January 11, 1991	Three underground storage tanks (UST) were removed and disposed.
January 21, 1991	UST leak and contamination report was submitted (IT 1999a).
March 1991	Groundwater samples collected at UST sites.
1991 to 1992	RCRA facility assessment (RFA) process initiated.
1992	RFA report published by DTSC (IT 1999a).
March 2, 1992	HF acid spill (476 gallons of 49 percent HF) into an unlined storm water retention pond (pH of 1.6); Fish bioassay showed 16 percent survival.
April 14, 1992	Regulatory agencies meet and express concern about hazardous materials releases at the site.
April 1993 to January 1994	Lagoon water effluent biomonitoring study conducted by MEC Analytical Systems Inc; results showed that the lagoon effluent was within the biotoxicity criteria set by RWQCB based on results that included median acute survival rates of 100 percent for specified organisms.
1994	RCRA permit renewal includes RCRA corrective action.

TABLE E2-2 (Continued)

GENERAL CHEMICAL COMPANY HISTORICAL TIMELINE

Date	Event
1995	RFI work plan, RFI field program, and report published; DTSC RFI approval and request for corrective measure study (CMS) work plan.
1995	Rhone Ploulenc property was sold to Polypure, Inc.
February 7, 1995	RWQCB issues a no–further-action letter for USTs at GCC.
October 30, 1995	Final RCRA facility investigation (RFI) report to investigate hazardous waste management unit (HWMU) 1 and the 11 solid waste management units (SWMU) identified in the RFI (GTI 1995). Samples analyzed for the report include 55 soil samples, 34 groundwater samples, and 4 sediment samples. A preliminary groundwater impact evaluation, including the installation of seven groundwater monitoring wells; a tidal study; and an aquifer pump test were conducted.
1996	CMS initiated as requested by DTSC.
1996	CMS work plan proposed three AOCs for future on-site source investigations.
1997	CMS task 1 activities work plan was developed to collect information from each AOC that was pertinent to the identified data gaps. The work plan included the collection of 70 soil samples from 39 borings, 20 groundwater samples from 8 permanent and 5 temporary wells, and 5 air samples.
1997	A tidal study and groundwater communication evaluation was performed to provide data on potential bay, lagoon, and groundwater interactions. Slug tests were also performed on three wells to define aquifer parameters.
April 1, 1997	Ten gallons of low pH wastewater with fluoride, chrome, and ammonia constituents released at site.
April 3, 1997	Five gallons of waste released on site.
1999	CMS task 1 activities report published (IT 1999a).
March 4, 1999	RCRA closure plan submitted.
September 1, 1999	Ten gallons of mixed waste acid (sulfuric and nitric acid) released at site.
September 24, 1999	DTSC inspection report submitted.
October 19, 1999	Case closure letter for USTs) at GCC.
October 21, 1999	DTSC project action plan for corrective action at GCC.
1999	DTSC Notice of Deficiency for CMS task 1
June 2000	DTSC approved RCRA CMS task 1 activities report with the understanding that supplemental work would be conducted to complete remaining data gaps in (1) hydrogeological conditions (vertical and lateral groundwater flow paths), (2) lateral (off site) and vertical (on site) extent of contamination, and (3) fate and transport concepts and parameters.
March 15, 2000	Technical memorandum on background metals in soil and groundwater submitted (Montgomery Watson 2000b).
March 20, 2000	Technical memorandum on fate and transport evaluation – metals in groundwater submitted (Montgomery Watson 2000c).
June 2000	DTSC approved background metal concentrations in soil document.

TABLE E2-2 (Continued)

GENERAL CHEMICAL COMPANY HISTORICAL TIMELINE

Date	Event
December 2000	Revised technical memorandum on work plan for on-site vertical gradient and chemistry evaluation report submitted (Montgomery Watson 2000e).

TABLE E2-3

PRODUCTS MANUFACTURED, PROCESSED, OR REPACKAGED AT ALLIED CHEMICAL FROM EPA (1984)

Product Name	Raw Ingredients	Years of Production
Products Manufactured at Allied Chemical Facility		
Sulfuric Acid	Pyrite ore, Sulfur	1905 to 1982
Alumina	Bauxtie ore	1910 to at least 1984
Lime Sulfur	Lime, Sulfuric Acid	1910 to 1970
Hydrofluoric Acid	Fluorspar, Boron, Silicon	1940 to 1983
Aluminum Fluoride	Fluorspar, Aluminum	1940 to 1961
Lead Arsenate	Lead, Arsenic	1940 to at least 1984
Styrofoam Cases	Polystyrene Beads	1950 to 1982
Polymer	Formaldehyde, dimethylamine, acrylamide	1981 to at least 1984
Ammonium Fluoride	Ammonia, HF Acid	1960 to 1983
Products Processed or Repackaged at Allied Chemical		
Acids	Chromic Acid	1940 to at least 1984
	Hydrochloric Acid	
	Acetic Acid	
	Nitric Acid	
	Miscellaneous	
Pesticides	DDT	1935 to 1965
	Toxaphene	
	Genite	
	Parathion	
	Super Phosphate	
	Aldrin	
	Dieldrin	
	Nicotine Sulfate	
	Ethion	
	Kepone	
	Miscellaneous	
Solvents	Isopropyl Alcohol	1950 to at least 1984
	Trichlorethane	
	Trichloroethylene	

TABLE E2-3 (Continued)

PRODUCTS MANUFACTURED, PROCESSED, OR REPACKAGED AT ALLIED CHEMICAL FROM EPA (1984)

Product Name	Raw Ingredients	Years of Production
Products Processed or Repackaged at Allied Chemical (Continued)		
Solvent (continued)	n-Butyl Acetate	1950 to at least 1984
	Others	
Alkalines	Ammonium Hydroxide	1940 to at least 1984
	Sodium Hydroxide	

ATTACHMENT E3

HISTORICAL GROUNDWATER DATA FOR THE LITIGATION AREA

WELL ID: 1AG02
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	6,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.1 J
Antimony	NA	NA	1,000 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	70	ND	14.4 J	ND	8	9.9	6.7 J	3.5	3.6 J	ND	ND	7	ND	13.9	14.1	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	135 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND
Calcium	NA	NA	500,000	540,000	650,000	628,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	470,000
Chromium	NA	NA	300	100	400	1,100 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	170
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	ND	ND	ND	43.8 J	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND
Iron	NA	NA	5,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	749
Lead	NA	NA	ND	ND	ND	ND	ND	ND	57.3	22.0 J	32.2 J	55	NA	NA	6.1	NA	13.8	ND	ND
Magnesium	NA	NA	900,000	980,000	1,150,000	1,280,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,500,000
Manganese	NA	NA	1,100 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,790
Mercury	NA	NA	0.6	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12.0 J
Potassium	NA	NA	140,000	180,000	190,000	207,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	221,000
Selenium	NA	NA	ND	ND	ND	ND	NA	ND	NA	NA	NA	8.0 J	4.0 J	ND	8	ND	ND	3.6	ND
Silver	NA	NA	ND	ND	ND	82.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	6,400,000	5,860,000	8,070,000	8,200,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9,130,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.85 J
Zinc	NA	NA	ND	300	ND	39.6 J	ND	ND	27.7	ND	ND	3.0 J	ND	ND	10.6	ND	ND	6.9	ND
Volatile Organic Compounds (µg/L																			
Acetone	NA	NA	13 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	ND	33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.07 JZ
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	1,160	780 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	15,500	20,100	18,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	1,690	3,260	3,480	4,360	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	20,000	20,000	20,000	26,400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	67	37	44.2	79	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Z	Other peaks; chromatogram does not suggest the presence of a fuel.

WELL ID: 1AG03
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	1,200 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	70	ND	43.1	40.0 J	22.8	16.1	47.8 J	132	83.0 J	41.6	34.2	19.6	57.1 J	27.1	47.1	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	0.67	NA
Calcium	NA	NA	330,000	320,000	360,000	345,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	ND	ND	ND	61.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	4.7	NA
Iron	NA	NA	2,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	ND	ND	ND	ND	ND	26.9 J	ND	12.8 J	22.8 J	27.6	NA	NA	4.1	NA	ND	ND	NA
Magnesium	NA	NA	820,000	770,000	830,000	907,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	500 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	0.4	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	120,000	110,000	130,000	131,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	ND	ND	ND	NA	ND	NA	NA	NA	8.0 J	4.0 J	ND	4	NA	ND	4	NA
Silver	NA	NA	ND	ND	ND	66.3 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	5,100,000	4,090,000	5,140,000	5,100,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	ND	200	ND	35.4 J	ND	ND	ND	ND	ND	3.0 J	ND	ND	6.4	71.2 J	ND	33.4	NA
Volatile Organic Compounds (µg/L)																			
Acetone	NA	NA	19 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	1,580	1,540 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	11,000	9,490	11,900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	910	1,470	1,410	2,700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	19,000	20,000	20,000	23,300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	97	60	92.8	180	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 1AG04
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.0 J
Antimony	NA	NA	800 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	28	70	ND	44.7 J	62.0 J	92.7	178	162 J	199	187 J	220	234	192	197 J	376	269	55.6
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	175 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND
Calcium	NA	NA	680,000	510,000	460,000	368,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	409,000
Chromium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16.6
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	ND	ND	ND	215 J	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND
Iron	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	62.8 J
Lead	NA	NA	ND	ND	ND	ND	ND	ND	16.2	ND	20.9 J	ND	NA	NA	25.4	NA	ND	ND	ND
Magnesium	NA	NA	480,000	540,000	590,000	654,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,070,000
Manganese	NA	NA	200 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	251
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.6 J
Potassium	NA	NA	140,000	150,000	160,000	122,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	164,000
Selenium	NA	NA	ND	ND	ND	ND	NA	26.5 J	NA	NA	NA	8.0 J	4.0 J	ND	8	NA	ND	3.2	ND
Silver	NA	NA	ND	ND	ND	37.9 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	6,300,000	5,030,000	5,760,000	5,130,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,170,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.1 J
Zinc	NA	NA	ND	300	ND	50.9 J	13.1	ND	35.6	ND	ND	3.0 J	ND	ND	9.2	ND	ND	10.3	ND
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L)																			
Phenol	NA	NA	160	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	1,130	920 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	12,300	13,500	17,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	790	910	960	1,170	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	20,000	19,400	20,000	21,800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	80	69	81.5	150	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 1MG01
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	1,000 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	60	ND	22.2	51.0 J	50.4	43.1	37.9 J	32.5	31.8 J	31.6 J	ND	10.1	41.6 J	41.9	32.2	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	340,000	280,000	290,000	276,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	300	ND	200	104 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	ND	ND	ND	ND	ND	3.5	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	NA
Iron	NA	NA	2,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	ND	ND	ND	ND	ND	12.7 J	ND	ND	20.5 J	ND	NA	ND	2.2	NA	ND	ND	NA
Magnesium	NA	NA	840,000	7,000,000	700,000	760,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	700 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	140,000	130,000	140,000	141,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	ND	ND	ND	NA	ND	NA	NA	NA	4.0 J	4.0 J	ND	8	NA	ND	4.5	NA
Silver	NA	NA	ND	ND	ND	78.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	5,600,000	4,230,000	4,980,000	4,950,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	ND	ND	ND	38.0 J	ND	ND	ND	ND	ND	3.0 J	ND	ND	1	ND	ND	18.5	NA
Volatile Organic Compounds (µg/L)																			
Acetone	NA	NA	12 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	1,320	1,250 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	12,200	9,340	10,700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	1,340	1,300	1,220	1,290	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	20,000	17,400	20,000	20,800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	42	29	43.2	140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 1PG05
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Antimony	NA	NA	1,800 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	ND	10.0 J	ND	23.0 J	3.2	ND	6.4	5.6	5.0 J	10.0 J	ND	7	ND	13.6	8.6	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	85.7 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	60.0 J	ND	ND	ND	ND	ND	3.8	ND	ND	ND	ND	ND	3.5	ND	ND	3.6	ND
Calcium	NA	NA	520,000	440,000	590,000	467,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	468,000
Chromium	NA	NA	300	ND	ND	533 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.1 J
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18.6 J
Copper	NA	NA	ND	ND	ND	ND	ND	4.8	ND	ND	ND	ND	ND	ND	2.6	ND	ND	ND	ND
Iron	NA	NA	9,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18,300
Lead	NA	NA	ND	ND	ND	ND	26	ND	19.8	21.0 J	21.2 J	33.4	NA	ND	4	NA	13.2	ND	ND
Magnesium	NA	NA	1,000,000	850,000	1,220,000	1,070,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,500,000
Manganese	NA	NA	4,300 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,450
Mercury	NA	NA	1.2	ND	0.80 J	0.69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.7
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	500	ND	ND	104 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.5
Potassium	NA	NA	150,000	160,000	160,000	128,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	179,000
Selenium	NA	NA	ND	ND	ND	ND	NA	ND	NA	NA	NA	4.0 J	4.0 J	8.0 J	20	NA	ND	3.5	ND
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	7,000,000	5,540,000	7,440,000	6,180,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8,990,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.2 J
Zinc	NA	NA	ND	300	ND	127 J	ND	ND	ND	ND	ND	3.0 J	ND	ND	13	ND	ND	12.4	ND
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 Z
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	1,420	1,100 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	14,000	14,400	15,900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	1,260	1,230	1,610	1,620	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	20,000	20,000	20,000	28,200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	55	48	45	140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Z	Other peaks; chromatogram does not suggest the presence of a fuel.

WELL ID: 1PG18
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	55.9
Antimony	NA	NA	1,000 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	14	10	ND	7.8 J	38.9 J	15	16.5	14.1	17.9	15.2 J	20.0 J	ND	7	ND	20.3	14.3	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	233
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	0.7	ND
Calcium	NA	NA	310,000	280,000	310,000	288,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	184,000
Chromium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.9
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND
Iron	NA	NA	40,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6,910
Lead	NA	NA	ND	ND	ND	ND	17	ND	ND	15.3 J	35.9 J	ND	NA	ND	4	28.9 J	ND	ND	ND
Magnesium	NA	NA	720,000	610,000	640,000	693,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	576,000
Manganese	NA	NA	3,900 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,280
Mercury	NA	NA	0.7	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.17 J
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.5 J
Potassium	NA	NA	40,000	140,000	140,000	126,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	99,500
Selenium	NA	NA	ND	ND	ND	ND	NA	22.3	NA	NA	NA	4.0 J	4.0 J	ND	8	NA	ND	2.6	ND
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	5,400,000	4,160,000	5,190,000	5,050,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5,070,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.7 J
Zinc	NA	NA	ND	200	ND	76.8 J	16.8	ND	ND	ND	ND	3.0 J	ND	ND	20.4	ND	ND	15.7	ND
Volatile Organic Compounds (µg/L)																			
1,1,1-Trichloroethane	NA	NA	19 J	14 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
1,1-Dichloroethane	NA	NA	ND	6 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Methylene Chloride	NA	NA	18 BJ	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	910	870 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate	NA	NA	ND	ND	1.0 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	10,900	9,640	10,700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	1,180	1,340	1,020	1,230	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	19,700	20,000	19,600	19,400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	71	53	66	150	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 2AG08
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	8,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	160 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	ND	ND	4.8 J	ND	ND	2.6 J	NA	NA	1.0 J	10.0 J	ND	7	ND	50.7	3.5	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	510,000	380,000	200,000	145,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	100	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	ND	ND	ND	ND	ND	ND	4.9	ND	ND	ND	ND	ND	5.4	ND	15.2	ND	NA
Iron	NA	NA	10,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	ND	ND	ND	ND	ND	19.9	ND	ND	13.5	NA	NA	ND	4	ND	ND	ND	NA
Magnesium	NA	NA	930,000	740,000	390,000	270,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	8,000 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	0.12 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	190,000	210,000	160,000	84,600 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	ND	ND	ND	NA	2.5	NA	NA	NA	NA	5.0 J	ND	10	ND	ND	4.1	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	8,400,000	7,060,000	5,100,000	4,070,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	ND	300	ND	47.4 J	23.8	19.8	ND	ND	ND	ND	ND	ND	549	ND	1,210	97.4	NA
Volatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	ND	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-N-Octylphthalate	NA	NA	ND	64	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	610	570 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	14,900	6,800	6,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	ND	ND	1	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	5,720	5,940	3,560	2,490	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	20,000	20,000	20,000	14,700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	22	22	19.5	57	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 2AG09
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	7,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	62.6
Antimony	NA	NA	700 J	600	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	20	10.0 J	5.8 J	ND	3.2	4.5 J	5.6 J	NA	2.2 J	10.0 J	ND	7	ND	23.2	4.8	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	43.5 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	60.0 J	ND	ND	ND	111	57.4	32.7	147	114	70.1	67	193	91.9	73.4 J	132	25	8.2
Calcium	NA	NA	330,000	260,000	82,000	78,800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	101,000
Chromium	NA	NA	ND	200	10	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.9
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.1 J
Copper	NA	NA	ND	ND	ND	ND	6.6	11	12.9	20.2	21.3	15.7	ND	ND	15.7	ND	18	8.8	6.9 J
Iron	NA	NA	8,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	228
Lead	NA	NA	100	1,000	15	31.4 J	ND	ND	ND	49.0 J	14.5	NA	NA	ND	4.2	ND	ND	2.2	ND
Magnesium	NA	NA	480,000	410,000	130,000	152,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	194,000
Manganese	NA	NA	10,000 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,410
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	36.5
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	59.2
Potassium	NA	NA	61,000	88,000	29,000	9,970 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	35,500
Selenium	NA	NA	ND	ND	ND	ND	NA	ND	NA	NA	NA	NA	5.0 J	ND	4	ND	ND	4.2	ND
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	3,900,000	2,970,000	1,920,000	1,700,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,310,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	33.6 J
Zinc	NA	NA	16,000	22,000	4,400	3,040	20,700	11,200	9,010	32,700	30,000	17,600 J	20,800	34,000	22,000	18,800	34,300	11,500	2,870 J
Volatile Organic Compounds (µg/L)																			
Methylene Chloride	NA	NA	6 BJ	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.06 JZ
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	690	710 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	6,730	3,340	3,130	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	ND	0.6	2	1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	2,540	2,210	1,100	1,100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	15,200	14,500	7,170	6,830	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	26	11	17.8	77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 2MG07
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	3,000	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Antimony	NA	NA	2,500 J	1,500	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	ND	NA	10	ND	ND	ND	ND	4.0 J	2.0 J	10.0 J	ND	7	ND	ND	2.1	ND
Barium	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21.8 J
Beryllium	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	NA	ND	ND	ND	5.2	ND	ND	ND	ND	ND	1.5	ND	ND	0.63	11.4
Calcium	NA	NA	740,000	500,000	NA	331,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	450,000
Chromium	NA	NA	ND	200	NA	2,800 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.3 J
Cobalt	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18.5 J
Copper	NA	NA	ND	ND	NA	52.6 J	ND	ND	8.7	11.4	ND	ND	ND	ND	3.9	ND	7.6	ND	2.1 J
Iron	NA	NA	6,000	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	296
Lead	NA	NA	ND	30	NA	ND	ND	62.3	13.7 J	48.3 J	40.9	NA	13.4 J	ND	9	290	ND	ND	ND
Magnesium	NA	NA	1,800,000	1,280,000	NA	713,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	996,000
Manganese	NA	NA	7,600 J	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,620
Mercury	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11
Nickel	NA	NA	ND	ND	NA	1,390	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.3
Potassium	NA	NA	290,000	280,000	NA	154,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	229,000
Selenium	NA	NA	ND	ND	NA	ND	ND	ND	NA	NA	NA	NA	5.0 J	ND	10	ND	ND	4.5	ND
Silver	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	15,000,000	9,670,000	NA	7,460,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10,400,000
Thallium	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.5 J
Zinc	NA	NA	ND	500	NA	94.6 J	ND	17.2	ND	ND	ND	ND	ND	ND	54.4	ND	ND	14	ND
Volatile Organic Compounds (µg/L)																			
Acetone	NA	NA	14 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Methylene Chloride	NA	NA	41 BJ	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L)																			
Di-N-Octylphthalate	NA	NA	ND	53 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 Z
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	480	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	33,800	NA	11,400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	7,810	6,220	NA	3,540	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	20,000	20,000	NA	20,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	28	22	NA	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Z	Other peaks; chromatogram does not suggest the presence of a fuel.

WELL ID: 2MG20
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	14,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	600	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	ND	51.0 NV	10	ND	ND	13	7.2	4.3	4.8 J	4.9 J	4.1 J	5.5 J	11.7 J	ND	7	ND	7	7.6	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	26.0 NV	30.0 NV	ND	ND	ND	ND	ND	ND	2.4	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	58,000	59,000	71,000	90,200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	ND	ND	ND	65.2 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	160 NV	30.0 NV	ND	ND	ND	60.7 J	6	5.9	7.2	5.5	ND	ND	ND	5.2	4.6	ND	4.2	2.5	NA
Iron	NA	NA	18,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	140 NV	230 NV	21.0 J	ND	ND	34.0 J	ND	ND	ND	ND	ND	NA	NA	ND	1	ND	ND	ND	NA
Magnesium	NA	NA	120,000	120,000	140,000	188,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	6,400 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	0.3	ND	ND	0.13 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	101 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	20,000	ND	ND	20,700 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	ND	66.0 NV	ND	ND	ND	ND	NA	ND	NA	44.4 J	NA	NA	5.0 J	43.5 J	2	ND	ND	4	NA
Silver	NA	NA	ND	ND	ND	32.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	2,600,000	2,150,000	2,650,000	3,170,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	40.0 NV	10.0 NV	ND	200	ND	154 J	24	ND	ND	ND	ND	26.4 J	ND	ND	20.8	ND	7.8	15.4	NA
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	ND	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-N-Octylphthalate	NA	NA	ND	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	640	620 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	6,250	3,340	4,810	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	2.3	2.1	2	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	2,200	1,940	2,270	2,440	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	8,600	9,030	9,820	9,680	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	14	14	5.5	65	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 2MG21
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	2,800	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	60.0 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	ND	21.0 NV	10	ND	10.0 J	8.5 J	6.6	4.2	5.8 J	6.2 J	7.4 J	5.8 J	11.4 J	ND	7	ND	9.8	7.3	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	ND	15.0 NV	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	27,000	ND	25,000	26,700 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	87.0 NV	20.0 NV	ND	ND	ND	ND	5.3	7.8	3.8	ND	ND	ND	ND	ND	5.2	ND	ND	ND	NA
Iron	NA	NA	3,800	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	64.0 NV	420 NV	7	15	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	1	20	ND	ND	NA
Magnesium	NA	NA	38,000	ND	34,000	38,100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	30.0 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	17.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	20,000	68,000	24,000	21,800 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	ND	15.0 NV	ND	ND	ND	ND	NA	ND	NA	NA	NA	NA	10.0 J	ND	2	24.4	ND	5.9	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	1,200,000	1,130,000	1,190,000	1,140,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	20.0 NV	70.0 NV	ND	200	ND	61	10.6	ND	ND	ND	ND	ND	ND	ND	32.5	ND	7.4	15.6	NA
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	580	570 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	1,130	820	850	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	1.3	1.2	2	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	1,400	2,030	1,390	1,490	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	4,260	4,300	4,280	4,140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	10	12	12	46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 2MG22
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	2,700	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	ND	14.0 NV	ND	ND	10.0 J	6.4 J	ND	ND	2.9 J	3.2 J	3.1 J	2.6 J	10.0 J	ND	7	ND	7.7	NA	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	1.1 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	12.0 NV	ND	ND	ND	ND	ND	ND	2.9	ND	ND	ND	ND	ND	ND	1	ND	NA	NA	NA
Calcium	NA	NA	200,000	170,000	170,000	208,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	ND	60	ND	27.1 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	77.0 NV	20.0 NV	ND	50	ND	133	ND	3.8	4.6	ND	ND	ND	ND	ND	2	ND	NA	NA	NA
Iron	NA	NA	3,200	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	110 NV	16.0 NV	7	30	ND	12.5 J	ND	ND	ND	ND	ND	NA	NA	ND	1.3	ND	1.2	NA	NA
Magnesium	NA	NA	98,000	94,000	86,000	110,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	5,600 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	60	ND	41.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	ND	6,000	ND	3,430 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	ND	15.0 NV	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	5.0 J	ND	2	ND	ND	NA	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	520,000	440,000	490,000	515,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	30.0 NV	60.0 NV	70.0 J	220	ND	126	6.9	ND	24.6	ND	ND	ND	ND	ND	6.6	ND	NA	NA	NA
Volatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L																			
Di-N-Octylphthalate	NA	NA	ND	150	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	370	360 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	770	640	650	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	1.1	0.7	2	1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	940	1,050	940	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	2,840	2,820	2,910	2,900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	5	3.0 J	7.8	31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 3AG10
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Antimony	NA	NA	90.0 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	ND	ND	4.2 J	3.3	4.4	4.4	5.3	5.2	ND	10.2 J	ND	7	6.3	4.6	4.3	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15.5 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND
Calcium	NA	NA	53,000	60,000	43,000	28,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	38,400
Chromium	NA	NA	520	310	10	10.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.6 J
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	ND	ND	ND	ND	4.1	3.4	6.6	ND	ND	ND	ND	ND	6.1	ND	ND	ND	ND
Iron	NA	NA	4,500	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.3 J
Lead	NA	NA	ND	ND	ND	1.2 J	ND	ND	ND	ND	ND	ND	3.5 J	ND	1.6	ND	ND	ND	ND
Magnesium	NA	NA	89,000	99,000	72,000	56,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	69,300
Manganese	NA	NA	990 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	209
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	43.7
Nickel	NA	NA	220	ND	40	122 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18.9 J
Potassium	NA	NA	23,000	35,000	26,000	32,800 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	23,500
Selenium	NA	NA	ND	ND	ND	ND	27.2	ND	ND	ND	4.0 J	ND	8.4 J	ND	4	ND	ND	2.8	5.5
Silver	NA	NA	ND	ND	ND	3.7 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	1,100,000	1,130,000	940,000	842,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,090,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.9 J
Zinc	NA	NA	ND	ND	ND	19.1 J	16.1	ND	ND	ND	ND	ND	ND	ND	8.2	ND	ND	16.5	ND
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L)																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	12 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.07 JZ
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	390	370 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	1,890	1,400	1,340	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	7.3	6.6	8	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	600	660	620	600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	3,880	4,390	3,800	3,470	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	5	10	3.8	4.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Z	Other peaks; chromatogram does not suggest the presence of a fuel.

WELL ID: 3MG06
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	600	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	ND	10.0 J	5.9 J	3.6	4.4	4.8	5.4	NA	6.2 J	ND	ND	7	6.8	6.6	4.8	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	88,000	76,000	72,000	65,900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	10	ND	20	12.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	ND	ND	ND	ND	4.1	ND	4.2	ND	ND	ND	ND	ND	2	ND	ND	ND	NA
Iron	NA	NA	1,300	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	8	ND	9	3.2 J	ND	ND	ND	3.5 J	ND	ND	ND	ND	7.8	ND	ND	ND	NA
Magnesium	NA	NA	58,000	52,000	46,000	49,800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	100 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	ND	ND	ND	12,100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	ND	ND	ND	2.8 J	ND	ND	NA	NA	NA	ND	ND	4	ND	ND	3.8	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	150,000	130,000	140,000	146,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	700	40	70	25.8 J	61.9	ND	ND	ND	12.2	ND	42.6 J	ND	58.8	ND	9	29.3	NA
Volatile Organic Compounds (µg/L)																			
Acetone	NA	NA	13 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	26 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	320	340 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	48	190	51	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	8.1	7.4	8	28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	390	380	610	410	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	1,030	970	1,000	1,060	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	3	7	6	3.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 3MG11
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	400	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.4 J
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	ND	ND	3.1 J	3.1	ND	ND	ND	NA	ND	10.0 J	ND	7	5.6	3.4	ND	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	121 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND
Calcium	NA	NA	97,000	91,000	89,000	79,800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	96,000
Chromium	NA	NA	220	20	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.0 J
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	ND	ND	ND	4.6 J	3.4	ND	3.5	ND	ND	3	ND	ND	3.6	ND	ND	ND	ND
Iron	NA	NA	1,700	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	265
Lead	NA	NA	ND	ND	ND	1.4 J	ND	ND	ND	6.0 J	ND	ND	2.0 J	ND	8.2	ND	ND	ND	ND
Magnesium	NA	NA	56,000	54,000	53,000	53,200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	57,700
Manganese	NA	NA	130 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	113
Mercury	NA	NA	0.4	0.4	ND	0.26 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.16 J
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	90	60	ND	24.2 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.2 J
Potassium	NA	NA	ND	ND	ND	1,030 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Selenium	NA	NA	ND	ND	ND	ND	ND	11.3 J	ND	NA	NA	NA	5.0 J	ND	4	ND	ND	ND	ND
Silver	NA	NA	ND	ND	ND	7.7 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	290,000	290,000	270,000	288,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	357,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18.1 J
Zinc	NA	NA	100 J	90	ND	33.0 J	65.4	ND	ND	ND	12.4	ND	ND	ND	67.8	ND	3.1	17.5	ND
Volatile Organic Compounds (µg/L																			
Acetone	NA	NA	13 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	13 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.07 JZ
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	660	670 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	490	310	270	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	160	150	140	140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	1,470	1,420	1,460	1,340	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	15	14	5.3	12.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Z	Other peaks; chromatogram does not suggest the presence of a fuel.

WELL ID: 3MG12
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	2,800	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	ND	ND	2.0 J	ND	ND	ND	ND	NA	ND	ND	ND	7	3.6	5	ND	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	28.9 J
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	1.4	ND	ND	ND
Calcium	NA	NA	250,000	220,000	230,000	197,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	214,000
Chromium	NA	NA	120	230	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.8 J
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	ND	ND	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	4.0 J
Iron	NA	NA	4,800	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	45.7 J
Lead	NA	NA	ND	ND	6	1.7 J	ND	ND	ND	10.2 J	2.4	ND	ND	ND	2.2	ND	ND	ND	ND
Magnesium	NA	NA	60,000	55,000	56,000	54,300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	55,500
Manganese	NA	NA	30.0 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Mercury	NA	NA	0.2	ND	ND	0.10 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	ND	ND	ND	28.3 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.8 J
Potassium	NA	NA	ND	ND	ND	2,260 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Selenium	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	5.0 J	ND	4	3.3	ND	2.8	15.1
Silver	NA	NA	ND	ND	ND	17.7 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	350,000	330,000	350,000	352,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	473,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	13.3 J
Zinc	NA	NA	40.0 J	80	30	24.7 J	78.4	ND	ND	ND	ND	ND	ND	ND	11.8	ND	1.8	32.7	ND
Volatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 Y
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	360	380 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	710	520	580	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	25	24	46	23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	460	520	550	540	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	2,290	2,220	2,250	2,220	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	3	6	5.5	6.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Y	Other fuel; chromatogram does not match quantitated fuel.

WELL ID: 3MG13
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	1,500	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	ND	10.0 J	4.7 J	ND	ND	ND	2.8	NA	ND	ND	ND	7	2.8	ND	3.4	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	320,000	300,000	260,000	286,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	40	10	20	9.4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	30	ND	ND	ND	6.6	ND	3.8	ND	ND	3.1	ND	ND	2	ND	ND	ND	NA
Iron	NA	NA	4,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	14	ND	ND	2.2 J	ND	ND	ND	4.4 J	2.4	ND	ND	ND	2.2	ND	ND	ND	NA
Magnesium	NA	NA	91,000	90,000	75,000	94,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	150 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	14.2 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	ND	ND	ND	5,400 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	9	ND	ND	ND	ND	ND	NA	NA	NA	5.0 J	ND	4	ND	ND	3.5	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	710,000	650,000	630,000	712,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	120 J	80	50	58.0 J	63.7	ND	43.2	ND	ND	ND	38.1 J	ND	58.1	ND	8.4	20.8	NA
Volatile Organic Compounds (µg/L																			
Acetone	NA	NA	15 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	21	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	240	490	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate	NA	NA	ND	25	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	130	220	190	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	0.5	11	2	0.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	1,890	76	2,000	2,260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	F	NA	4,020	550	3,980	4,060	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	7	11	11.8	4.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 3MG14
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	3,700	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	ND	10.0 J	5.4 J	2.6	5.2	4.1	4.6	5.5	ND	10.0 J	ND	7	8.8	7.7	2.8	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	0.46	NA
Calcium	NA	NA	21,000	57,000	50,000	37,100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	40	30	40	19.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	ND	ND	ND	3.2 J	3.8	ND	ND	ND	ND	ND	ND	ND	2.9	ND	ND	ND	NA
Iron	NA	NA	4,600	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	ND	ND	ND	4.3 J	ND	ND	ND	ND	3.8	ND	4.2 J	ND	1	ND	ND	ND	NA
Magnesium	NA	NA	12,000	17,000	12,000	19,700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	100 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	0.10 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	15.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	ND	ND	ND	1,640 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	4.0 J	ND	5.0 J	ND	4	ND	ND	2.6	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	130,000	120,000	136,000	144,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	80	70	30	25.8 J	ND	ND	ND	ND	ND	36.1	ND	ND	13.6	ND	5.6	10.9	NA
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
Bis(2-Ethylhexyl)Phthalate	NA	NA	11 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	480	160 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	190	120	140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	8.5	0.9	10	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	66	210	66	69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	520	3,840	530	690	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	3	2	3.8	8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 3MG19
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	2,400	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	ND	ND	23.4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	ND	ND	ND	10.0 J	3.5 J	ND	3.6	2.7	2.3	4.5	ND	10.0 J	ND	7	4	4	ND	NA
Barium	NA	NA	200	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	1.6 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	110,000	100,000	92,000	101,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	20	10	20	15.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	20.0 NV	ND	ND	ND	13.8 J	ND	ND	3.1	ND	ND	3.2	ND	ND	4.9	ND	ND	ND	NA
Iron	NA	NA	3,400	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	7.2 NV	7	ND	ND	6.7 J	ND	ND	ND	ND	3.3	ND	2.0 J	ND	3.4	1.3	ND	ND	NA
Magnesium	NA	NA	54,000	46,000	42,000	47,800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	250 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	ND	ND	ND	28.7 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	ND	ND	ND	922 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	ND	ND	ND	ND	ND	2.6 J	ND	ND	ND	4.0 J	ND	5.0 J	ND	4	ND	ND	3.7	NA
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	110,000	100,000	100,000	104,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	ND	210	140	30	46.1	ND	ND	ND	ND	ND	ND	ND	ND	57.9	ND	19.2	15.5	NA
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	240	230 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	350	410	370	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	3.8	4.2	4	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	16	22	17	19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	890	870	930	860	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	4	1	4.8	8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 4MG15
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	10,300	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Antimony	NA	NA	190 J	ND	ND	43.2 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	10	ND	10	11.6	ND	4.3	3.1	ND	2.0 J	4.2 J	ND	ND	7	2.6	ND	3.8	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	64.6 J
Beryllium	NA	NA	ND	ND	ND	3.4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND
Calcium	NA	NA	150,000	170,000	200,000	199,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	335,000
Chromium	NA	NA	100	30	450	1,060	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21.1
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Copper	NA	NA	40	ND	30	51.6 J	43.7	10.2	26.4	21.2	42.2	8.3	37	64.6	27.3	ND	15.1	ND	2.8 J
Iron	NA	NA	13,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	132
Lead	NA	NA	10	6	7	8.6	ND	ND	ND	3.4 J	2.7	ND	ND	ND	4	10.5 J	ND	ND	ND
Magnesium	NA	NA	95,000	110,000	130,000	138,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	197,000
Manganese	NA	NA	510 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Mercury	NA	NA	ND	ND	ND	0.11 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Nickel	NA	NA	140	80	840	2,380	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	233
Potassium	NA	NA	ND	ND	ND	3,230 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,620 J
Selenium	NA	NA	ND	ND	ND	ND	17.3 J	ND	ND	18.2	NA	NA	5.0 J	5.3 J	6.7	ND	ND	10.4	17.8
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	350,000	410,000	460,000	492,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	552,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.8 J
Zinc	NA	NA	210	70	80	97.6	39.5	ND	21	ND	ND	ND	ND	ND	29.1	ND	4	14.6	ND
Volatile Organic Compounds (µg/L																			
Bromoform	NA	NA	7 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	270	280 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	890	910	1,130	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	22	34	41	42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	340	470	500	510	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	1,960	2,460	2,760	2,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	7	9	3.3	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

WELL ID: 4MG16
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	2,700	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.3 J
Antimony	NA	NA	80.0 J	ND	ND	21.6 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	ND	ND	ND	2.8 J	ND	ND	ND	2.6	2.0 J	ND	ND	ND	7	ND	4.1	ND	ND
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	54.7 J
Beryllium	NA	NA	ND	ND	ND	1.4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND
Calcium	NA	NA	69,000	64,000	74,000	71,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	283,000
Chromium	NA	NA	60	20	230	349	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	214
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.1 J
Copper	NA	NA	ND	ND	ND	27.6 J	ND	8.7	26.7	21.1	108	6	86	10	4.6	25.3	34.6	8.4	4.1 J
Iron	NA	NA	4,600	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	393
Lead	NA	NA	ND	ND	ND	1.6 J	ND	ND	ND	ND	1.9	ND	3.2	ND	4	ND	ND	ND	ND
Magnesium	NA	NA	48,000	45,000	56,000	54,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	161,000
Manganese	NA	NA	480 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	466
Mercury	NA	NA	ND	ND	ND	0.13 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	26.3
Nickel	NA	NA	60	140	2,900	1,520	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	255
Potassium	NA	NA	ND	ND	ND	976 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,140 J
Selenium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA	7.1 J	5.0 J	2.9 J	4	ND	5	7.2	9.8
Silver	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Sodium	NA	NA	240,000	250,000	270,000	286,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	367,000
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.6 J
Zinc	NA	NA	60	40	40	37	14.8	ND	15.9	ND	ND	ND	ND	ND	13.3	ND	15.1	21.1	ND
Volatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Semivolatile Organic Compounds (µg/L																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Pesticides/PCBs (µg/L)																			
None Detected	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
TPH-Extractables (mg/L)																			
Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Motor Oil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.09 JZ
TPH-Purgeables (mg/L)																			
Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	290	330 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	420	490	510	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	0.3	0.1	ND	0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	180	220	200	200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	1,310	1,180	1,440	1,400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	8	5	4.8	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Z	Other peaks; chromatogram does not suggest the presence of a fuel.

WELL ID: 4MG17
(Former ID: R1W2)

Sampling Event	May-87	Aug-87	Feb-89	May-89	Aug-89	Nov-89	Mar-91	Jun-91	Oct-91	Jan-92	Mar-92	Jul-92	Sep-92	Dec-92	Mar-93	Jun-93	Mar-94	Jul-94	Oct-96
Filtered Metals (µg/L)																			
Aluminum	NA	NA	2,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	ND	ND	ND	3.1 J	ND	ND	ND	ND	4.0 J	ND	ND	ND	7	ND	ND	3	NA
Barium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
Calcium	NA	NA	92,000	91,000	93,000	79,300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	300	330	140	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	ND	ND	ND	ND	33.2	5.7	ND	ND	ND	13	ND	ND	6.6	ND	6.2	2.7	NA
Iron	NA	NA	10,000	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	ND	ND	ND	1.3 J	ND	ND	ND	ND	8.4	ND	ND	ND	4	ND	ND	ND	NA
Magnesium	NA	NA	150,000	150,000	150,000	155,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	1,500 J	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	0.3	ND	ND	0.10 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	1,000	940	520	166 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	45,000	52,000	ND	167,000 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	5.0 J	ND	4	ND	ND	ND	NA
Silver	NA	NA	ND	ND	ND	45.8 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	2,000,000	2,000,000	2,180,000	2,330,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	800	200	30	87.8 J	24.6	ND	8.8	ND	ND	ND	ND	ND	23.1	ND	ND	10.6	NA
Volatile Organic Compounds (µg/L)																			
None Detected	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)																			
Di-N-Octylphthalate	NA	NA	ND	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (µg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/L)																			
Not Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anions, TDS, and TOC (mg/L)																			
Bicarbonate	NA	NA	ND	390	400 J	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	NA	NA	ND	3,940	3,610	3,910	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	ND	0.2	0.5	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	760	800	790	820	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	NA	NA	6,700	7,150	7,980	7,750	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	11	14	19.5	13.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

J	Estimated value
µg/L	Microgram per liter
mg/L	Milligram per liter
NA	Not analyzed
ND	Not detected
PCB	Polychlorinated biphenyl
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons

ATTACHMENT E4

BORING AND WELL LOGS

1MG01

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R1W-1	COORDINATES: N - 568125.47 E - 1571834.70	DATE: 12/19/88
ELEVATION: 3.30 FT	GWL:Depth - SURFACE Date/Time - 11/1/88 TOB*	DATE STARTED: 11/1/88
GEOLOGIST: C. WALLACE	Depth - 2.92 Date/Time - 12/8/88 - 1054	DATE COMPLETED: 11/2/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				CLAY - 75%, some SILT - 20%, trace WOODY FIBERS - 5%, medium brown, wet, low plasticity.	cl	
- -				CLAY - 70%, some SILT - 25%, trace fine SAND - 5%, brownish gray, wet, low to medium plasticity.	cl	slight sulfurous odor
- 5 -					ol/oh	
- -				CLAY - 80%, some SILT - 20%, dark gray, wet medium plasticity.		strong sulfurous odor
- -						
- -						
- -						
-10 -						
- -						
- -						
- -						
- -						
-15 -						
- -						
- -						
- -						
- -						
-20 -				TOTAL DEPTH - 19 FT BGS*		
- -						
- -						
- -						
- -						
-25 -						
- -						
- -						
- -						
- -						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-89OR21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

1AG02

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R1W-2	COORDINATES: N - 567738.31 E - 1571780.85	DATE: 12/19/88
ELEVATION: 2.76 FT	GWL:Depth - SURFACE Date/Time - 11/10/88 TOB*	DATE STARTED: 11/10/88
GEOLOGIST: C. WALLACE	Depth - 3.15 Date/Time - 12/8/88 - 1048	DATE COMPLETED: 11/10/8
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				CLAY - 65%, some SILT - 35%, w/ rootlets, dark gray, wet, low to medium plasticity.	ol	strong sulfuro odor
- -				CLAY - 80%, some SILT - 20%, dark gray, wet, medium to high plasticity.	oh	strong sulfuro odor
- 5 -						
- -						
- -						
- -						
- -						
-10 -						
- -				CLAY - 90%, trace SILT - 10%, dark gray, wet, high plasticity.	oh	strong sulfuro odor
- -						
- -						
-15 -						
- -						
- -						
- -						
- -						
-20 -				TOTAL DEPTH - 20 FT BGS*		
- -						
- -						
- -						
- -						
-25 -						
- -						
- -						
- -						
- -						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

I T CORPORATION

VISUAL CLASSIFICATION OF SOILS

1A603

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R1W-3	COORDINATES: N - 567249.80 E - 1571789.90	DATE: 11/21/88
ELEVATION: 2.98 FT	GWL:Depth - SURFACE Date/Time - 11/2/88 TOB*	DATE STARTED: 11/2/88
GEOLOGIST: C. WALLACE	Depth - 3.00 Date/Time - 12/8/88 - 1037	DATE COMPLETED: 11/2/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				CLAY - 75%, some SILT - 20%, trace fine SAND - 5%, dark gray w/rootlets, wet, low to medium plasticity.	cl	
				CLAY - 65%, some SILT - 35%, dark gray, wet, low to medium plasticity.	ol	strong sulfurous odor
5						
10				CLAY - 50%, and SILT - 45%, trace fine SAND - 5%, dark gray w/ greenish gray stringers, wet, low to medium plasticity.	ol/oh	strong sulfurous odor
15						
				TOTAL DEPTH - 18 FT BGS*		
20						
25						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-89OR21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

PAGO4

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R1W-4	COORDINATES: N - 567464.70 E - 1571532.90	DATE: 11/21/88
ELEVATION: 2.76 FT	GWL:Depth - SURFACE Date/Time - 11/10/88 TOB*	DATE STARTED: 11/10/88
GEOLOGIST: C. WALLACE	Depth - 3.01 Date/Time - 12/8/88 - 1026	DATE COMPLETED: 11/10/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				ORGANIC MATTER - 50%, and CLAY - 45%, trace SILT - 5%, dark gray, wet, low plasticity.	pt	strong sulfurous odor
5				CLAY - 95%, trace SILT - 5%, dark gray, wet, high plasticity.	ch	strong sulfurous odor
10				CLAY - 85%, trace SILT - 10%, trace very fine SAND - 5%, dark gray, wet, high plasticity.	ch	strong sulfurous odor
15						
20				TOTAL DEPTH - 20 FT BGS*		
25						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

VISUAL CLASSIFICATION OF SOILS

1P505

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R1W-5	COORDINATES: N - 566940.44 E - 1571353.67	DATE: 11/21/88
ELEVATION: 3.72 FT	GWL:Depth - 4.5 FT Date/Time - 11/9/88 TOB*	DATE STARTED: 11/9/88
GEOLOGIST: C. WALLACE	Depth - 5.70 FT Date/Time - 12/8/88 - 1019	DATE COMPLETED: 11/9/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 65%, some CLAY - 35%, grayish brown, moist, w/rootlets, low plasticity.	ml	
- -				CLAY - 55%, and SILT - 45%, brownish gray, very moist, medium to high plasticity.	ch	
- 5 -				CLAY - 90%, trace SILT - 10%, dark gray, wet, high plasticity.	ch	
-10 -						
-15 -				CLAY - 75%, some SILT - 20%, trace very fine SAND - 5%, greenish gray, wet, high plasticity.	ch	
-20 -				TOTAL DEPTH - 19 FT BGS*		
-25 -						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG06

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-4	COORDINATES: N - 565761.92 E - 1571654.68	DATE: 11/21/88
ELEVATION: 25.72 FT	GWL:Depth - 29.0 FT Date/Time - 11/2/88 TOB*	DATE STARTED: 11/2/88
GEOLOGIST: C. WALLACE	Depth - 25.30 FT Date/Time - 12/8/88 - 0949	DATE COMPLETED: 11/2/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 45%, and CLAY - 40%, some fine SAND - 15%, strong brown, moist, low plasticity.	ml	
- 5 -				CLAY - 75%, some SILT - 25%, light brown, moist, high plasticity.	ch	
- -				SILT - 65%, some fine SAND - 30%, trace CLAY - 5%, light brown, moist, low plasticity.	ml	
-10 -						
-15 -				SILT - 55%, and CLAY - 40%, trace fine SAND - 5%, light brown, moist, low plasticity	ml	
-20 -						
- -				SILT - 75%, some fine SAND - 20%, trace CLAY - 5%, light brown, very moist, low plasticity.	ml	
-25 -				CLAY - 60%, some SILT - 30%, trace fine SAND - 10%, light brown, moist, high plasticity.	ch	

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG06

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-4	COORDINATES: N - 565761.92 E - 1571654.68	DATE: 11/21/88
ELEVATION: 25.72 FT	GWL:Depth - 29.0 FT Date/Time - 11/2/88 TOB*	DATE STARTED: 11/2/88
GEOLOGIST: C. WALLACE	Depth - 25.30 FT Date/Time - 12/8/88 - 0949	DATE COMPLETED: 11/2/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				CLAY - 50%, and SILT - 45%, trace fine SAND - 5%, medium brown, wet, medium plasticity.	cl	
- -				SILT - 45%, and CLAY - 45%, trace fine SAND - 10%, medium brown, wet, low plasticity.	ml	
-35 -						
- -						
- -						
- -						
- -				TOTAL DEPTH - 38 FT BGS*		
-40 -						
- -						
- -						
- -						
- -						
-45 -						
- -						
- -						
- -						
- -						
-50 -						
- -						
- -						
- -						
- -						
-55 -						
- -						
- -						
- -						
- -						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

2MG07

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R2W-1	COORDINATES: N - 566880.52 E - 1571081.71	DATE: 11/21/88
ELEVATION: 3.94 FT	GWL:Depth - 4.0 FT Date/Time - 11/8/88 TOB*	DATE STARTED: 11/8/88
GEOLOGIST: C. WALLACE	Depth - 5.90 FT Date/Time - 12/8/88 - 0958	DATE COMPLETED: 11/9/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				SILT - 75%, some CLAY - 25%, light brown, dry, w/rootlets, low plasticity.	ml	
				CLAY - 60%, some SILT - 35%, trace fine SAND - 5%, dark brownish gray, very moist, low to medium plasticity.	cl	
5				CLAY - 90%, trace SILT - 10%, dark gray, wet, high plasticity.	ch	
				CLAY - 70%, some SILT - 25%, trace fine SAND - 5%, gray, wet, high plasticity.	ch	
10				CLAY - 70%, some SILT - 30%, greenish gray, wet, high plasticity.	ch	
15				CLAY - 85%, some SILT - 15%, light brown, wet, high plasticity.	ch	
20				TOTAL DEPTH - 19 FT BGS*		
25						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

2 AG-03

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD		
BORING NUMBER: R2W-2	COORDINATES: N - 566820.16 E - 1570699.91		DATE: 11/21/88
ELEVATION: 4.09 FT	GWL:Depth - 5.0 FT	Date/Time - 11/8/88 TOB*	DATE STARTED: 11/8/88
GEOLOGIST: C. WALLACE	Depth - 5.65 FT	Date/Time - 12/8/88 - 1001	DATE COMPLETED: 11/9/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER			PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				CLAY - 50%, and SILT - 50 %, dark brown, dry, low plasticity.	cl/ml	
- -				SILT - 45%, and CLAY - 40%, some very fine SAND - 15%, dark gray wet, low plasticity.	ml	
- -				CLAY - 75%, some SILT - 25%, very dark gray, very moist, medium to high plasticity.	ch	
- 5 -				CLAY - 90%, trace SILT - 10%, dark gray, wet, high plasticity.	ch	
- -					ch	
- -						
- -						
-10 -						
- -				CLAY - 80%, trace SILT - 10%, trace fine SAND - 10%, brown, very moist, high plasticity.	ch	
- -						
-15 -						
- -				SILT - 70%, some CLAY - 20%, trace fine SAND - 10%, light brown, wet, low plasticity.	ml	
-20 -						
- -				TOTAL DEPTH - 20 FT BGS*		
-25 -						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

2AG09

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R2W-3	COORDINATES: N - 566749.10 E - 1570401.95	DATE: 11/21/88
ELEVATION: 3.59 FT	GWL:Depth - 8.0 FT Date/Time - 11/7/88 TOB*	DATE STARTED: 11/7/88
GEOLOGIST: C. WALLACE	Depth - 5.11 FT Date/Time - 12/8/88 - 1004	DATE COMPLETED: 11/7/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 75%, some CLAY - 25%, light reddish brown, dry, w/rootlets, low plasticity.	ml	
- -				SILT - 45%, and CLAY - 45%, some fine SAND - 10%, dark grayish brown, very moist, medium plasticity.	ml/cl	
- 5 -				CLAY - 65%, some SILT - 35%, dark brownish gray, very moist, medium to high plasticity.	ch	
-10 -				CLAY - 60%, some SILT - 40%, dark olive brown, very moist, low plasticity.	cl	
				CLAY - 95%, trace SILT - 5%, strong brown, moist, high plasticity.	ch	
-15 -						
-20 -				CLAY - 60%, some SILT - 35%, trace fine SAND - 5%, light brown, wet, low plasticity.	cl	
-25 -				TOTAL DEPTH - 24 FT BGS*		

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3 A 5 10

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-1	COORDINATES: N - 566630.94 E - 1569834.41	DATE: 11/21/88
ELEVATION: 5.50 FT	GWL:Depth - 6.0 FT Date/Time - 11/6/88 TOB*	DATE STARTED: 11/6/88
GEOLOGIST: C. WALLACE	Depth - 6.12 FT Date/Time - 12/8/88 - 0920	DATE COMPLETED: 11/6/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 90%, trace CLAY - 10%, dark brownish gray, slightly moist, low plasticity.	ml	
- -						
- -						
- -						
- 5 -						
- -				CLAY - 55%, and SILT - 45%, dark gray, moist, high plasticity. medium to high plasticity.	ch	slight hydrocarbo odor
- -				CLAY - 45%, and very fine SAND - 45%, trace SILT - 10%, brown, very moist, low plasticity.	cl	slight hydrocarbo odor
- -						
-10 -						
- -				CLAY - 50%, and SILT - 45%, trace fine SAND - 5%, light brown, moist, low plasticity.	cl	very slight hy- carbon odor
- -						
- -						
-15 -				CLAY - 45%, and SILT - 45%, trace fine SAND - 10%, buff, wet, low plasticity.	cl/ml	no odor
- -						
- -						
- -					cl	
-20 -						
- -						
- -						
- -						
-25 -				TOTAL DEPTH - 24 FT BGS*		
- -						
- -						
- -						
- -						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG11

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-2	COORDINATES: N - 566290.07 E - 1570835.38	DATE: 11/21/88
ELEVATION: 12.43 FT	GWL:Depth - 16.0 FT Date/Time - 11/6/88 TOB*	DATE STARTED: 11/6/88
GEOLOGIST: C. WALLACE	Depth - 12.46 FT Date/Time - 12/8/88 - 0926	DATE COMPLETED: 11/6/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 55%, and CLAY - 45%, dark grayish brown, moist, low plasticity.	ml	
- -						
- -						
- 5 -						
- -				CLAY - 55%, and SILT - 45%, dark grayish brown, moist, medium to high plasticity.	ch	
- -						
-10 -				CLAY - 50%, and SILT - 45%, trace alluvial gravel to cobbles, dark gray, very moist, low to medium plasticity.	cl	
- -				SILT - 50%, and CLAY - 50%, dark brown, very moist, low plasticity.	ml/cl	
-15 -				SILT - 45%, and very fine SAND - 40%, some CLAY - 15%, olive brown, very moist, low plasticity.	ml	
- -				CLAY - 55%, some very fine SAND - 25%, some SILT - 20%, strong brown, very moist, sow plasticity.	cl	
-20 -				CLAY - 60%, some SILT - 40%, light brown, wet, low plasticity.	cl	
- -				CLAY - 40%, and SILT - 40%, some fine SAND - 20%, buff, wet, low plasticity.	cl/ml	
-25 -						

* TOB - Time Of Boring
BGS - Below Ground Surface

TOTAL DEPTH - 30 FT BGS*

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3 MG12

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-3	COORDINATES: N - 566043.50 E - 1571210.41	DATE: 11/21/88
ELEVATION: 17.71 FT	GWL:Depth - 17.0 FT Date/Time - 11/5/88 TOB*	DATE STARTED: 11/5/88
GEOLOGIST: C. WALLACE	Depth - 17.65 FT Date/Time - 12/8/88 - 0930	DATE COMPLETED: 11/6/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 50%, and CLAY - 50%, dark grayish brown, moist, low plasticity.	ml/cl	
- 5 -						
- -				SILT - 45%, and CLAY - 40%, some very fine SAND - 15%, light brown, moist, low plasticity.	ml	
-10 -				SILT - 60%, some CLAY - 35%, trace very fine SAND - 5%, medium brown, moist, low plasticity.	ml	
-15 -						
- -				Fine SAND - 55%, some SILT - 40%, trace CLAY - 5%, brownish red, wet.	sm	
-20 -						
- -				SILT - 50%, and fine SAND - 45%, trace CLAY - 5%, strong brown, wet, low plasticity.	ml	
-25 -						
- -				TOTAL DEPTH - 28 FT BGS*		

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG13

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-5	COORDINATES: N - 565677.39 E - 1571153.35	DATE: 11/21/88
ELEVATION: 23.39 FT	GWL:Depth - 24.0 FT Date/Time - 11/5/88 TOB*	DATE STARTED: 11/5/88
GEOLOGIST: C. WALLACE	Depth - 23.62 FT Date/Time - 12/8/88 - 0935	DATE COMPLETED: 11/5/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 90%, some CLAY - 10%, very dark gray to black, dry, low plasticity.	ml	
- 5 -						
-10 -				SILT - 65%, some very fine SAND - 30%, trace CLAY - 5%, brown and grayish brown, moist, low plasticity.	ml	
-15 -				SILT - 50%, and CLAY - 50%, light brown, very moist, low plasticity	ml/cl	
				SILT - 40%, and CLAY - 40%, some fine SAND - 20%, light brown, moist, low plasticity.	ml/cl	
-20 -				SILT - 45%, and fine SAND - 40%, some CLAY - 15%, brown, very moist, low plasticity.	ml	
-25 -				Fine SAND - 50%, and SILT - 40%, trace CLAY - 10%, light brown, wet.	sm	
				CLAY - 55%, some SILT - 35%, trace fine SAND - 10%, light brown, wet, low plasticity.	cl	

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG13

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-5	COORDINATES: N - 565677.39 E - 1571153.35	DATE: 11/21/88
ELEVATION: 23.39 FT	GWL:Depth - 24.0 FT Date/Time - 11/5/88 TOB*	DATE STARTED: 11/5/88
GEOLOGIST: C. WALLACE	Depth - 23.62 FT Date/Time - 12/8/88 - 0935	DATE COMPLETED: 11/5/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				CLAY - 80%, some SILT - 15%, trace very fine SAND - 5%, buff, wet, low to medium plasticity.	cl	
				TOTAL DEPTH - 38 FT BGS*		

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG14

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-6	COORDINATES: N - 565107.33 E - 1571050.39	DATE: 11/21/88
ELEVATION: 45.91 FT	GWL:Depth - 47.0 FT Date/Time - 10/26/88 TOB*	DATE STARTED: 10/26/88
GEOLOGIST: C. WALLACE	Depth - 44.42 FT Date/Time - 12/8/88 - 0940	DATE COMPLETED: 11/1/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				CLAY - 50%, and SILT - 50%, brown, dry to slightly moist, low plasticity.	cl/ml	
- 5 -				CLAY - 50%, and SILT - 50%, light brown, slightly moist, low plasticity.	cl/ml	
- -				SILT - 75%, some CLAY - 25%, light brown and tan, slightly moist, low plasticity.	ml	
-10 -				SILT - 60%, some CLAY - 40%, light brown, slightly moist, low plasticity	ml	
- -				Alluvial GRAVEL to COBBELS - 55%, some SILT - 25%, some CLAY - 20%, strong brown, slightly moist.	gm	
-15 -				SILT - 45%, and CLAY - 45%, trace alluvial GRAVEL - 10%, brown, moist, low plasticity.	ml/cl	
-20 -				Alluvial GRAVEL to COBBELS - 65%, some fine SAND - 25%, trace SILT - 5%, trace CLAY - 5%, dark brown, moist.	gm	
-25 -				SILT - 55%, some CLAY - 40%, trace alluvial SAND to GRAVEL - 5%, dark brown, moist, low plasticity.	ml	
- -				CLAY - 55%, some SILT - 35%, trace fine SAND - 10%, light brown, wet, low plasticity.	cl	

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG-14

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R3W-6	COORDINATES: N - 565107.33 E - 1571050.39	DATE: 11/21/88
ELEVATION: 45.91 FT	GWL:Depth - 47.0 FT Date/Time - 10/26/88 TOB*	DATE STARTED: 10/26/88
GEOLOGIST: C. WALLACE	Depth - 44.42 FT Date/Time - 12/8/88 - 0940	DATE COMPLETED: 11/1/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 55%, and CLAY - 45%, brown, moist, low plasticity.	ml	
-35 -						
				CLAY - 55%, and SILT - 45%, brown and strong brown, moist, low plasticity.	cl	
-40 -				SILT - 75%, some CLAY - 20%, trace fine SAND - 5%, brown to light brown, moist, low plasticity.	ml	
-45 -						
				SILT - 65%, some CLAY - 25%, trace fine SAND - 10%, light brown, very moist, low to medium plasticity.	ml	
-50 -						
				SILT - 85%, trace CLAY - 10%, trace very fine SAND - 5%, light brown, wet, low plasticity.	ml	
-55 -						

* TOB - Time Of Boring
BGS - Below Ground Surface

TOTAL DEPTH - 59 FT BGS*

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

4MG-15

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R4W-3	COORDINATES: N - 565139.84 E - 1573776.05	DATE: 11/21/88
ELEVATION: 21.02 FT	GWL:Depth - 19 FT Date/Time - 10/28/88 TOB*	DATE STARTED: 10/28/88
GEOLOGIST: C. WALLACE	Depth - 21.45 FT Date/Time - 12/8/88 - 1112	DATE COMPLETED: 10/30/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
- -				SILT - 65%, some CLAY - 30%, trace very coarse SAND - 5%, brownish gray, dry, low plasticity.	ml	
- -						
- -						
- 5 -						
- -						
- -						
- -				SILT - 50% and CLAY - 45%, trace medium SAND and GRAVEL - 5%, tan and tannish brown, slightly moist, low plasticity.	ml	
- -						
-10 -						
- -						
- -						
- -				SILT - 50% and CLAY - 50%, olive brown, moist, low to medium plasticity.	ml/cl	
-15 -				SILT - 50% and CLAY - 48%, trace medium SAND - 2%, brown, very moist, medium plasticity.	ml	
- -						
- -						
- -						
-20 -				SILT - 60%, some CLAY - 35%, trace fine SAND - 5%, brown, wet, medium plasticity.	ml	
- -						
- -				SILT - 45% some CLAY - 30%, some medium to coarse SAND - 25%, strong brown, wet, low plasticity.	ml	
- -						
-25 -						
- -						
- -						
- -						
- -						

* TOB - Time Of Boring
BGS - Below Ground Surface

TOTAL DEPTH - 29 FT BGS*

PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

4MG16

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R4W-1	COORDINATES: N - 564619.75 E - 1574035.89	DATE: 11/21/88
ELEVATION: 23.47 FT	GWL:Depth - 22.5 FT Date/Time - 10/28/88 TOB*	DATE STARTED: 10/28/88
GEOLOGIST: C. WALLACE	Depth - 24.00 FT Date/Time - 12/8/88 - 1119	DATE COMPLETED: 10/29/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				CLAY - 55%, and SILT - 45%, dark brownish gray, slightly moist, medium plasticity.	cl	
5				SILT - 50%, some CLAY - 35%, some very fine SAND - 15%, brown and tan, slightly moist, low plasticity.	ml	
10				Very fine SAND - 80%, trace SILT - 10%, trace CLAY - 10%, brown, slightly moist.	sm	
15				Very fine SAND - 85%, trace SILT - 15%, dark grayish brown, moist.	sm	
20				Very fine SAND - 85%, trace SILT - 10%, trace CLAY - 5%, strong brown, very moist.	sm	
25				Very fine and fine SAND - 95%, trace SILT - 5%, dark brownish gray, wet.	sw	

* TOB - Time Of Boring
BGS - Below Ground Surface

TOTAL DEPTH - 31 FT BGS*

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

4MG17

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R4W-2	COORDINATES: N - 564888.11 E - 1574342.67	DATE: 11/21/88
ELEVATION: 13.50 FT	GWL:Depth - 12 FT Date/Time - 10/30/88 TOB*	DATE STARTED: 10/30/88
GEOLOGIST: C. WALLACE	Depth - 14.19 FT Date/Time - 12/8/88 - 1124	DATE COMPLETED: 10/30/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				SILT - 75%, some CLAY - 25%, dark brown, dry, low plasticity.	ml	
				SILT - 75%, some CLAY - 20%, trace fine SAND - 5%, dark brown dry, low plasticity.	ml	
5						
				SILT - 50% and fine SAND - 45%, trace CLAY - 5%, brown, slightly micaceous, slightly moist, low plasticity.	ml	
10						
				Very fine SAND - 65%, some SILT - 30%, trace CLAY - 5%, brown, micaceous, moist.	sm	
				Very fine and fine SAND - 75%, some SILT - 25%, brown, slightly micaceous, wet.	sm	
15						
				Very fine SAND - 65%, some SILT - 30%, trace CLAY - 5%, brown, wet.	sm	
20						
				TOTAL DEPTH - 22 FT BGS*		
25						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

26 18

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 409619.52	PROJECT NAME: NWS CONCORD	
BORING NUMBER: R1W-6	COORDINATES: N - 567169.89 E - 1570955.74	DATE: 11/21/88
ELEVATION: 2.95 FT	GWL:Depth - SURFACE Date/Time - 11/9/88 TOB*	DATE STARTED: 11/9/88
GEOLOGIST: C. WALLACE	Depth - 4.65 FT Date/Time - 12/8/88 - 1012	DATE COMPLETED: 11/9/88
DRILLING METHODS: CME 750 W/ 8" ID HOLLOW STEM AUGER		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO. (NA)	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	REMARKS
				CLAY - 75%, some SILT - 25%, dark gray to black, wet, medium to high plasticity.	ch	slight sulfurous odor
5				CLAY - 90%, trace SILT - 10%, black, wet, high plasticity.	oh	strong sulfurous odor
10						
15				CLAY - 80%, some SILT - 20%, dark gray, wet, high plasticity.	oh	strong sulfurou odor
20				TOTAL DEPTH - 20 FT BGS*		
25						

* TOB - Time Of Boring
BGS - Below Ground Surface

PROJECT: NAVAL WEAPONS STATION CONCORD
LOCATION: CONCORD, CALIFORNIA
CLIENT: MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.: DE-AC05-890R21400
IT PROJECT NO.: 409619/409769
DRILLING CO: DATUM EXPLORATION, INC.

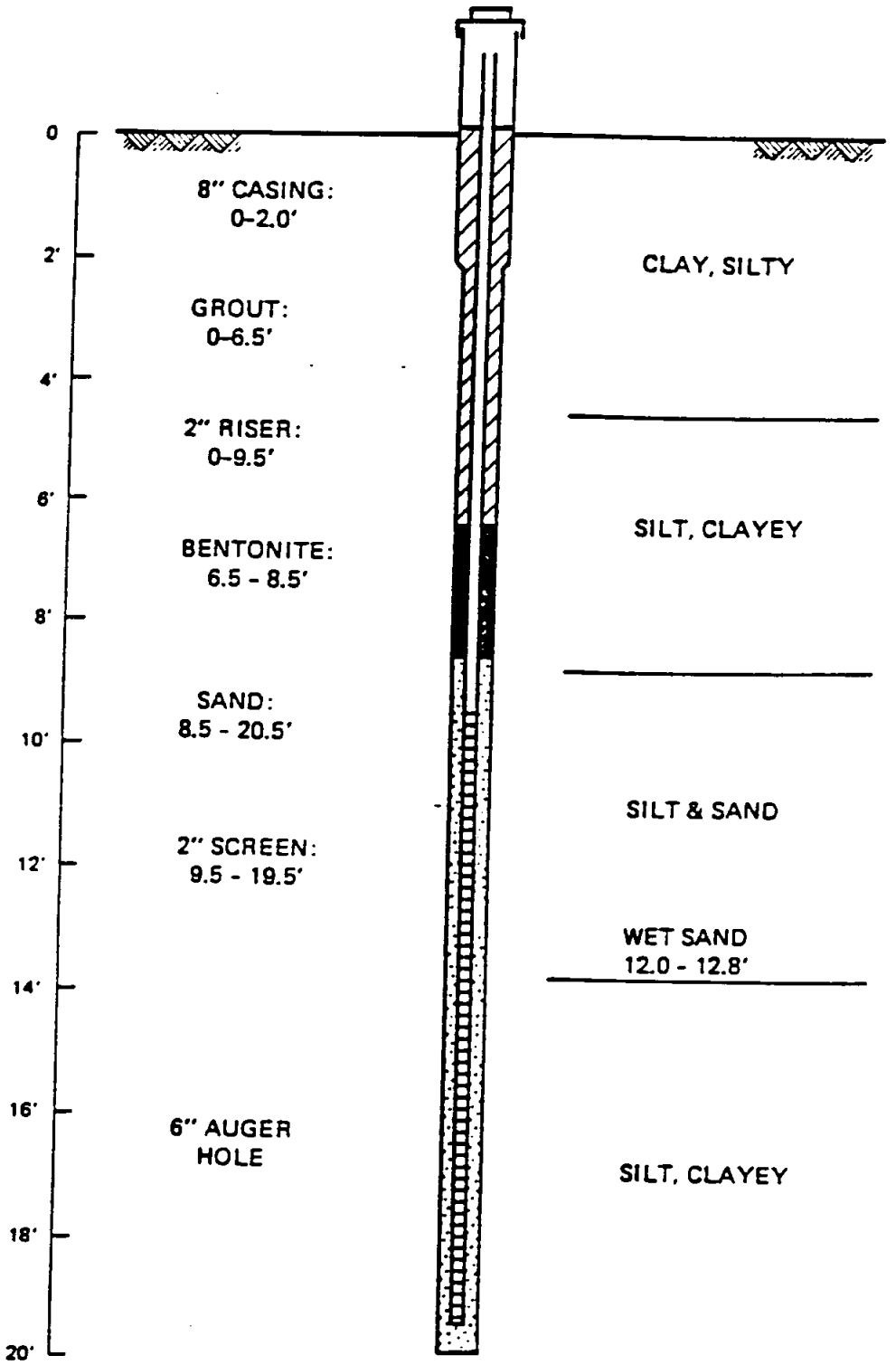
INTERNATIONAL TECHNOLOGY CORPORATION

3MG19
(WESH)

DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
		CLAY (CH) fat, organic, silty below 2.4	100		
			100	1	
		4.8			
		SILT (ML), clayey, sandy, w/ some gravel, w/ sand seams 5.2-5.3, 8.3-8.4, sand/gravel seam 7.5-7.7	85	2	
				3	
			100	4	
				5	
10			90	6	
				7	
			85	8	
		15.9	70	9	
		GRAVEL, sand + silt (GM)	0		
		19.6			
		SILT (ML) clayey w/ gravel	100	10	
20		20.7		11	
		CLAY silt, sand + gravel (GC)	100		Hard drilling 20.5-22.9
		24.3	100		
		SILT (ML), clayey, w/ some gravel, w/ sand/gravel seam 31.2-31.3, sand seams 32.2-32.3, 32.5-33.7	85	12	
			100		
30			100	13	
				14	
			100	15	
		36.8	100		
		CLAY and SILT (CL-ML) w/ some gravel + sand seams	100		
40			100	16	
			0		Drilled 42.1-47.5 w/ rotary rockbit
		48.1		17	
		SAND (SM), silty, dense, w/ mica	100		Hard drilling 47.5-49.9
50			0		Drilled 49.9-55.0 w/ rotary rockbit
			100		
			0		Drilled 57.4-61.0 w/ rotary rockbit
60		61.0			
		TOTAL DEPTH 61.0 FT			

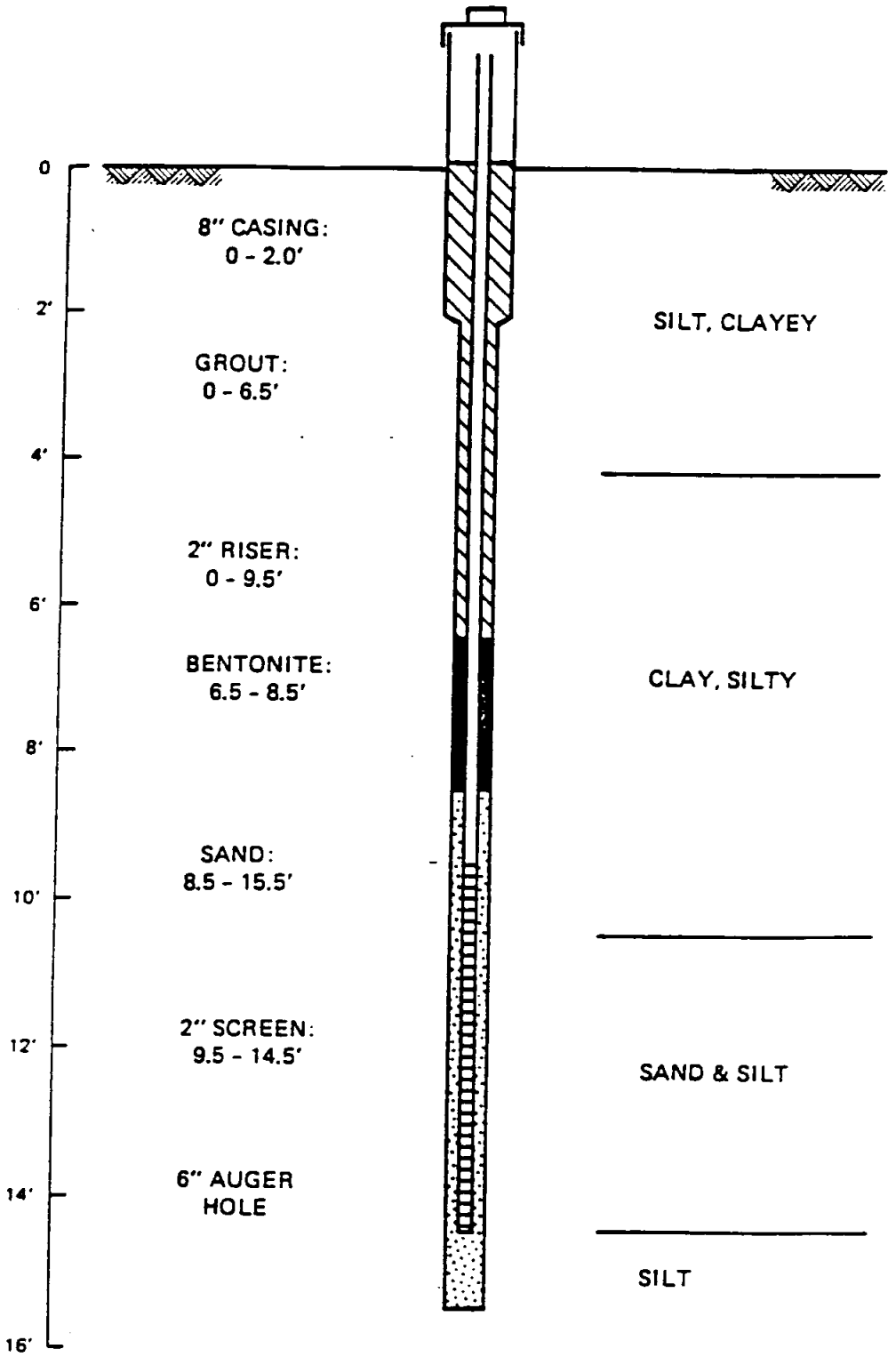
Figure 21. Log of drill hole at Site 10

2MG20



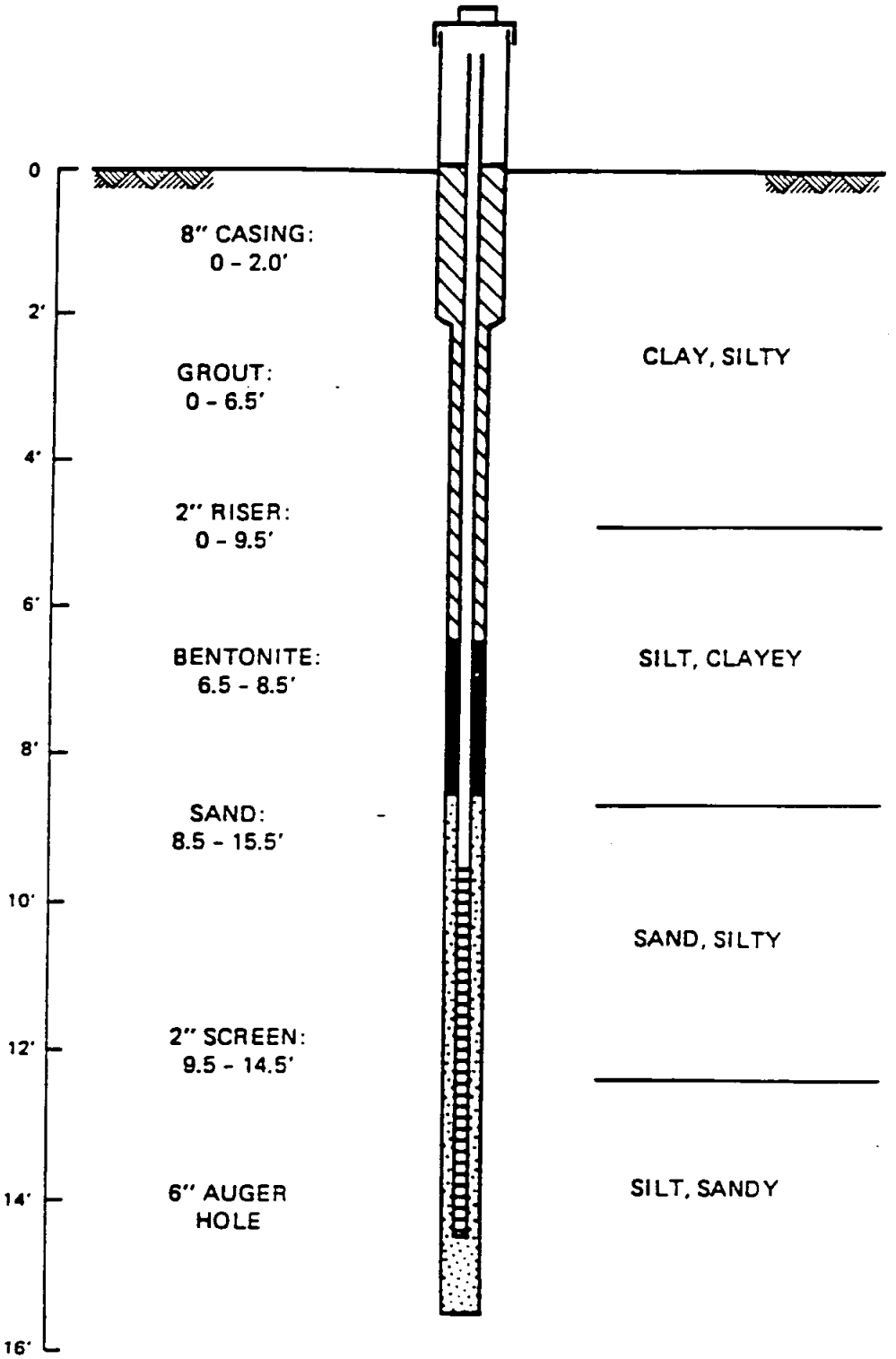
Well Number WES-1
Monitoring Well Installed by WES.

2 MG 21



Well Number WES-2
Monitoring Well Installed by WES.

2MG22

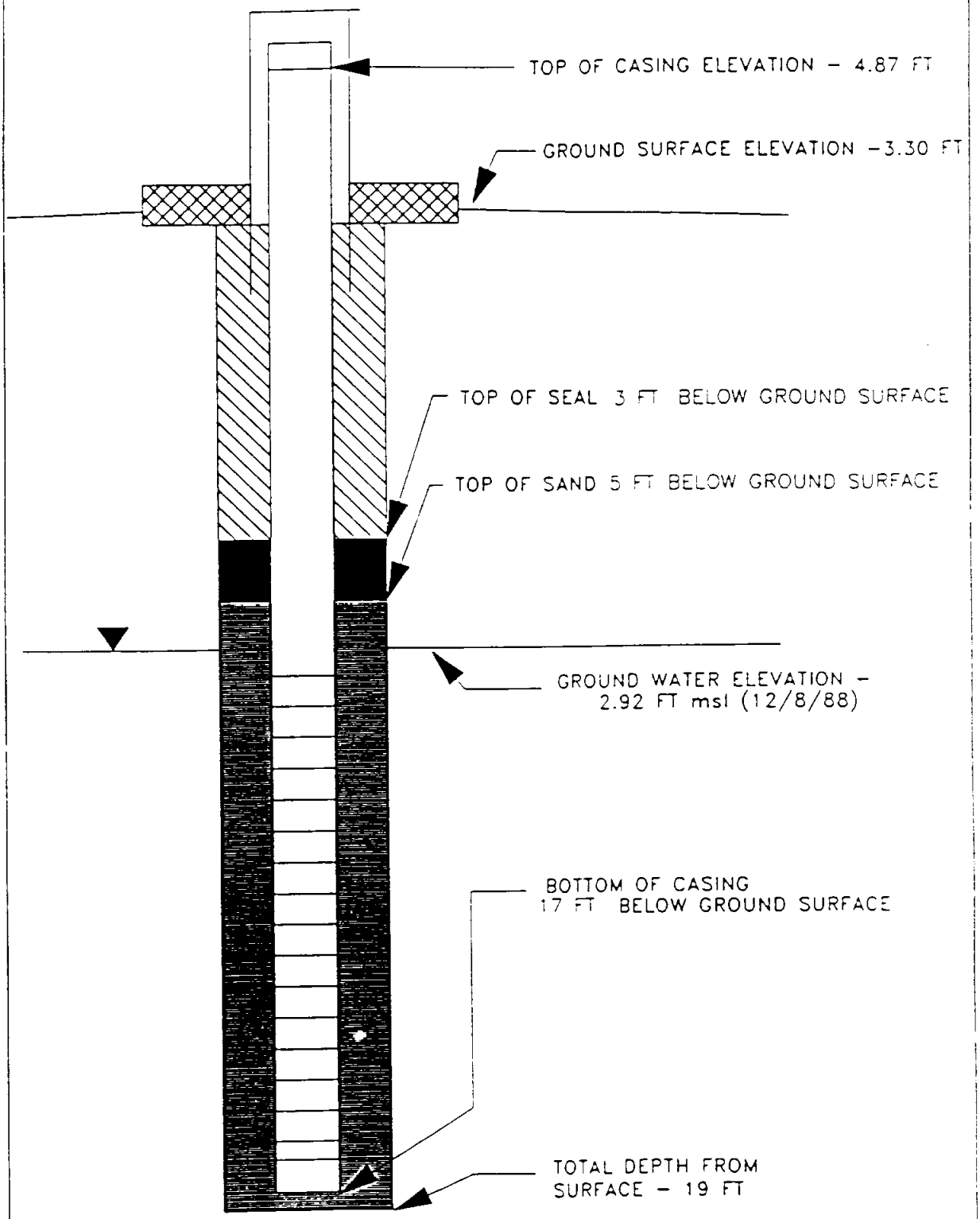


Well Number WES-3
Monitoring Well Installed by WES.

IMG 01

WELL NUMBER - R1W-1

N - 568125.47
E - 1571834.70



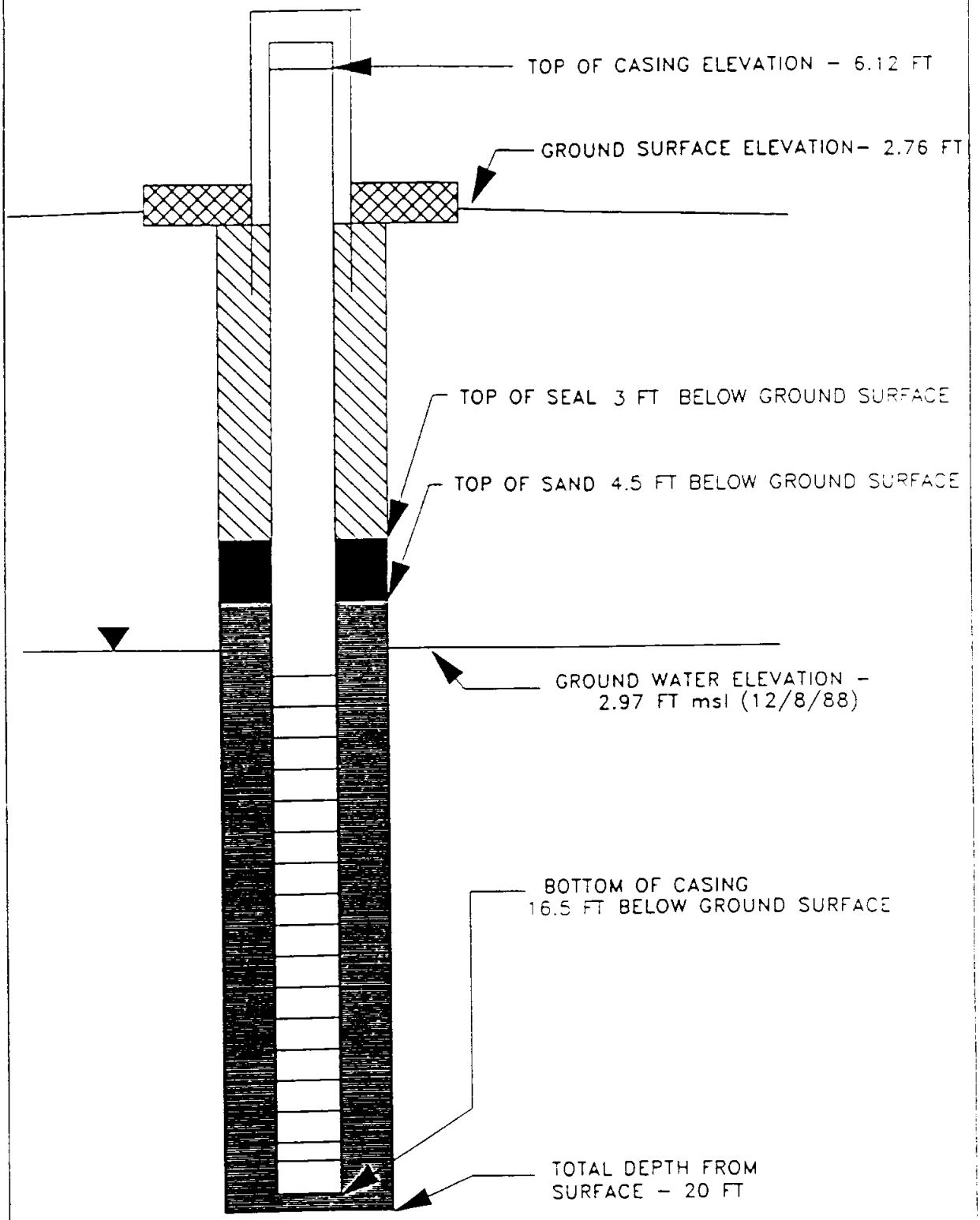
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

1AG02

WELL NUMBER - R1W-2

N - 567738.31
E - 1571780.85



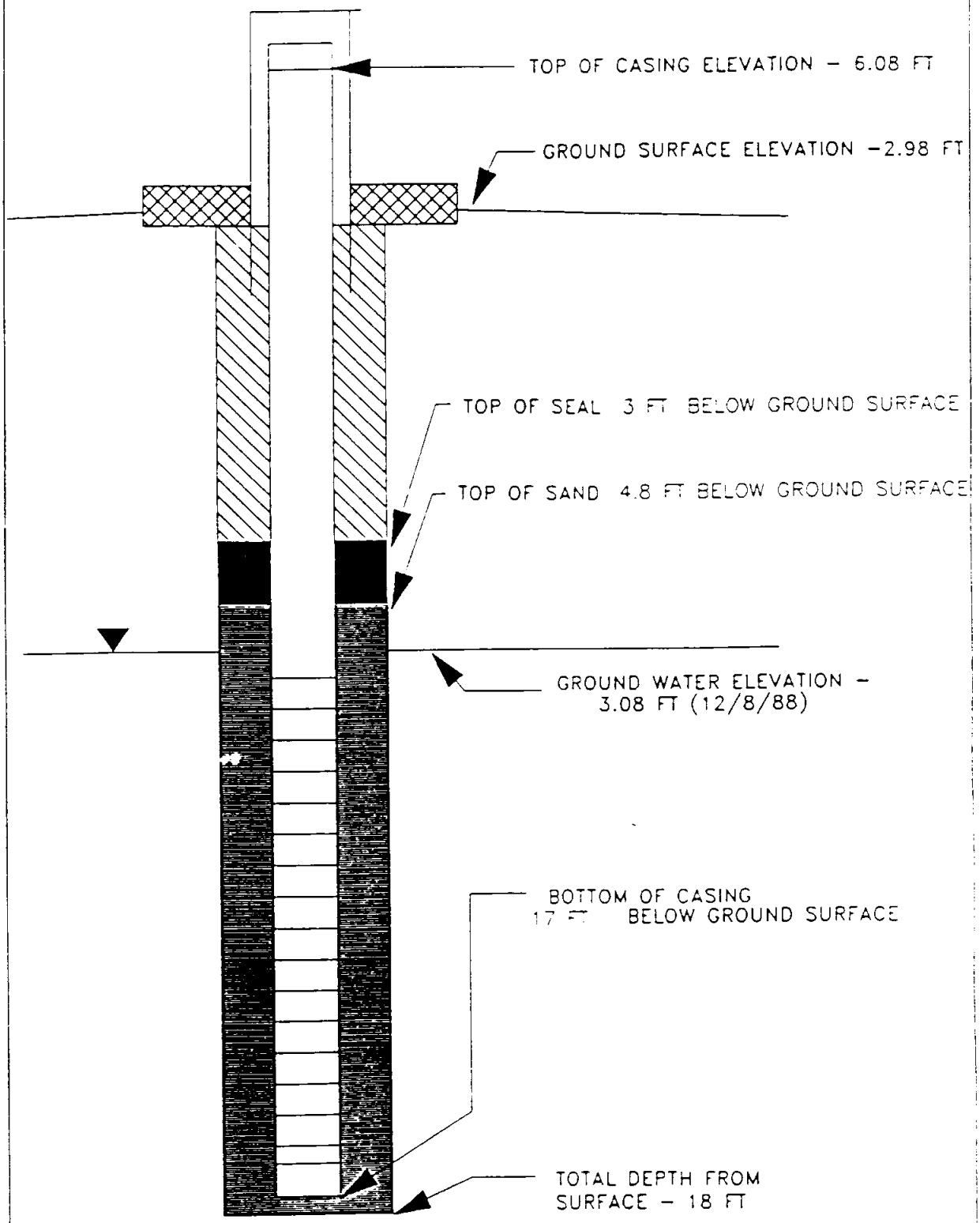
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

1AGC3

WELL NUMBER - R1W-3

N - 567249.80
E - 1571789.90



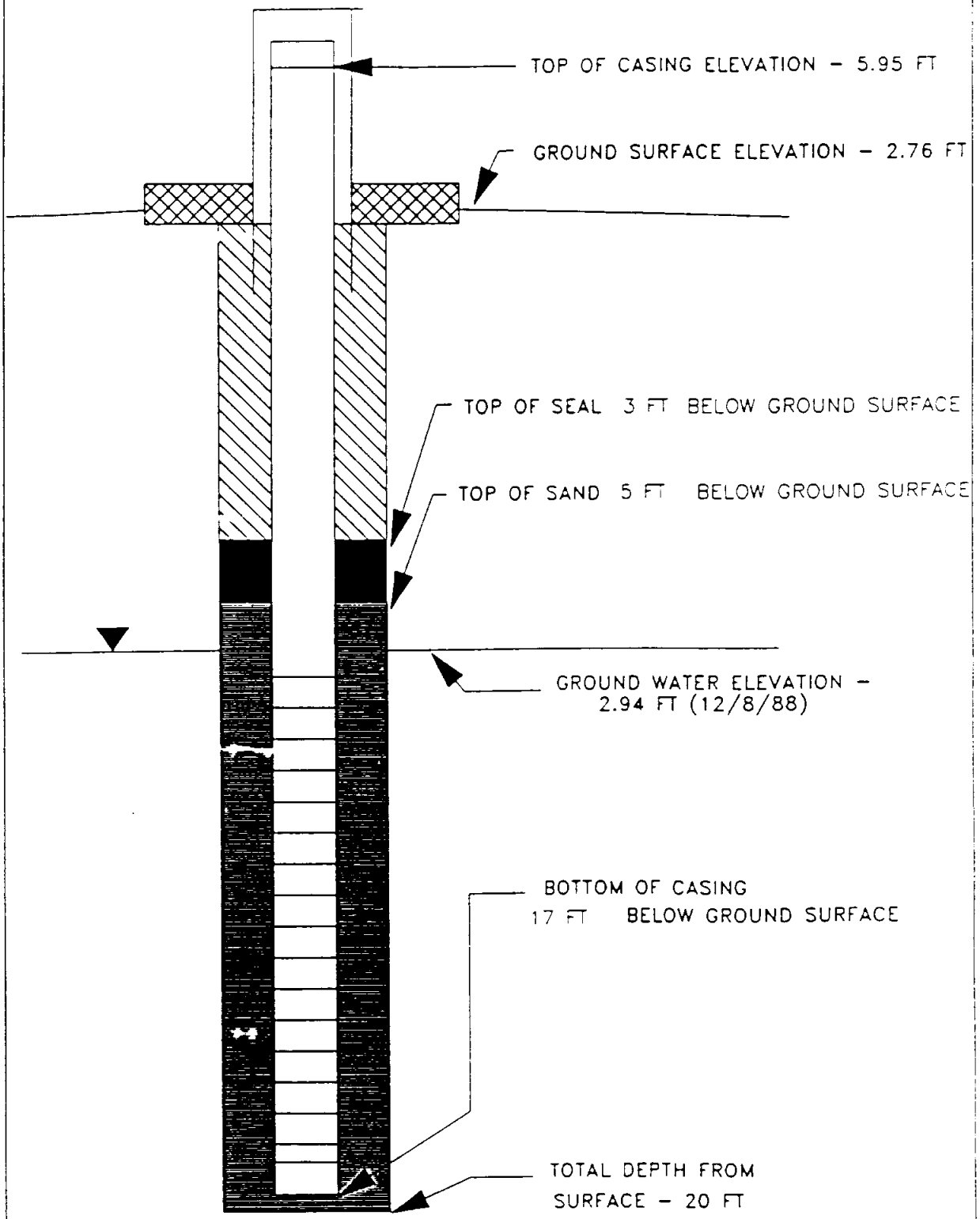
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

1AG04

WELL NUMBER - R1W-4

N - 567464.70
E - 1571532.90



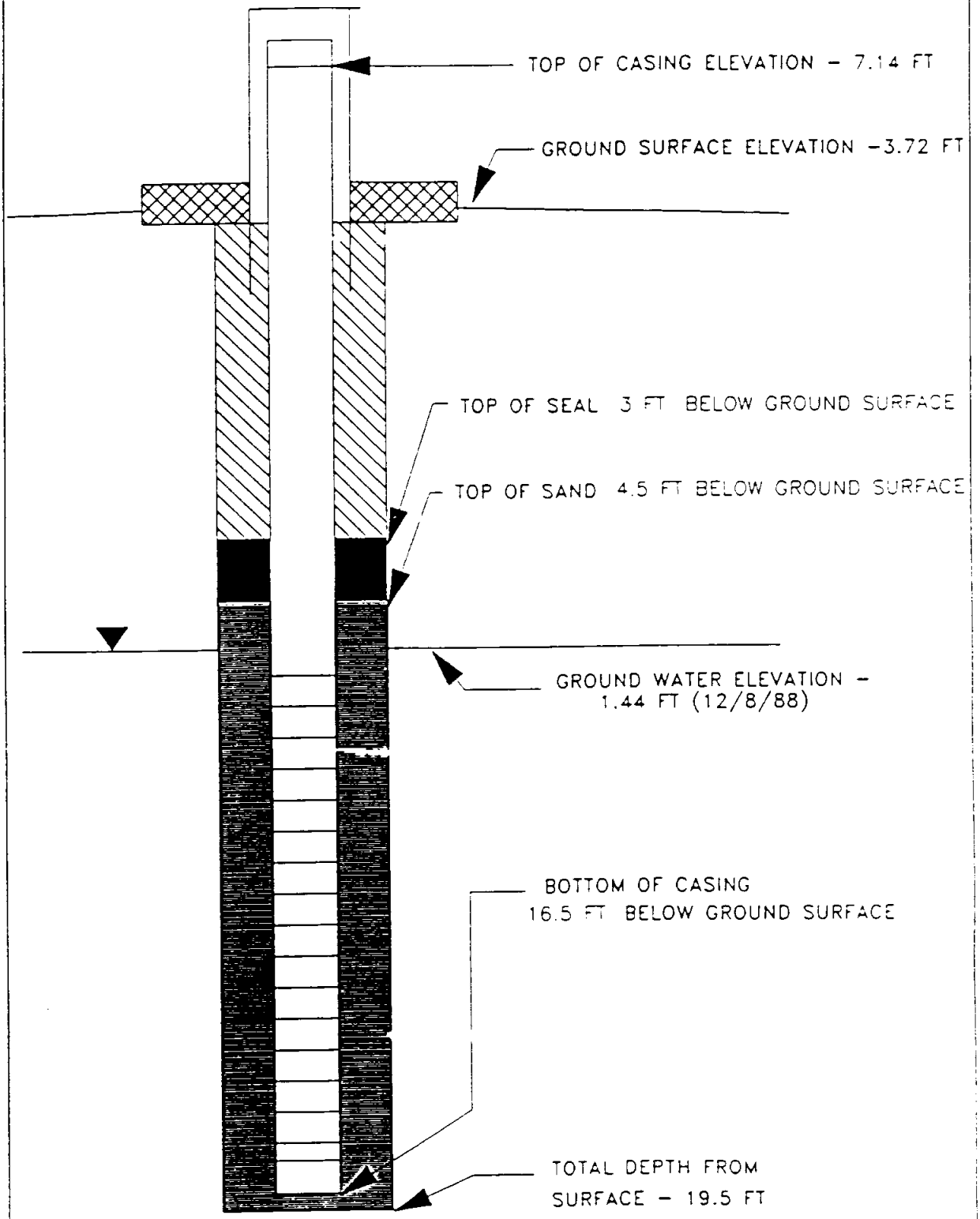
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

1PG05

WELL NUMBER – R1W-5

N – 566940.44
E – 1571353.67



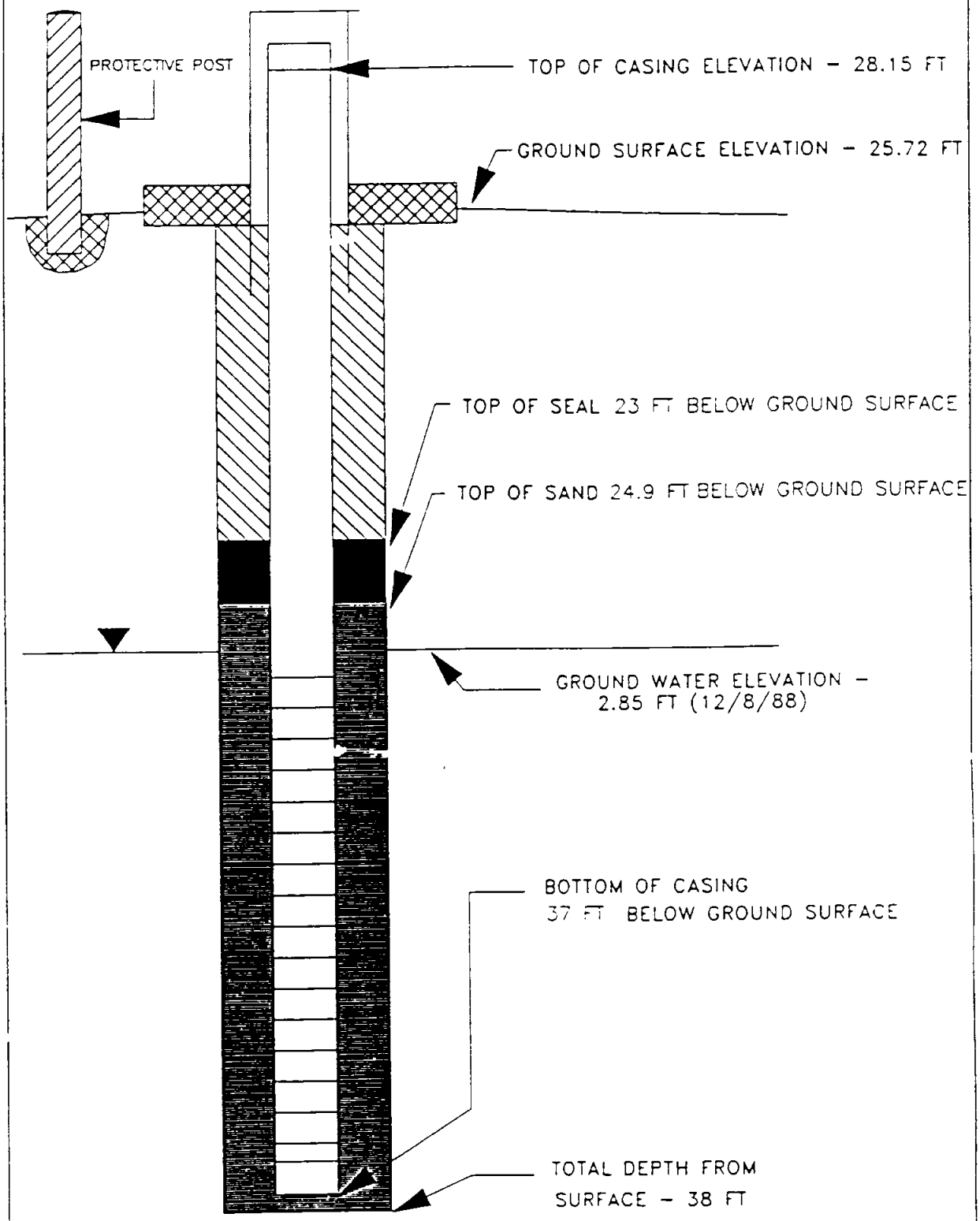
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

3MG06

WELL NUMBER - R3W-4

N - 565761.92
E - 1571654.68



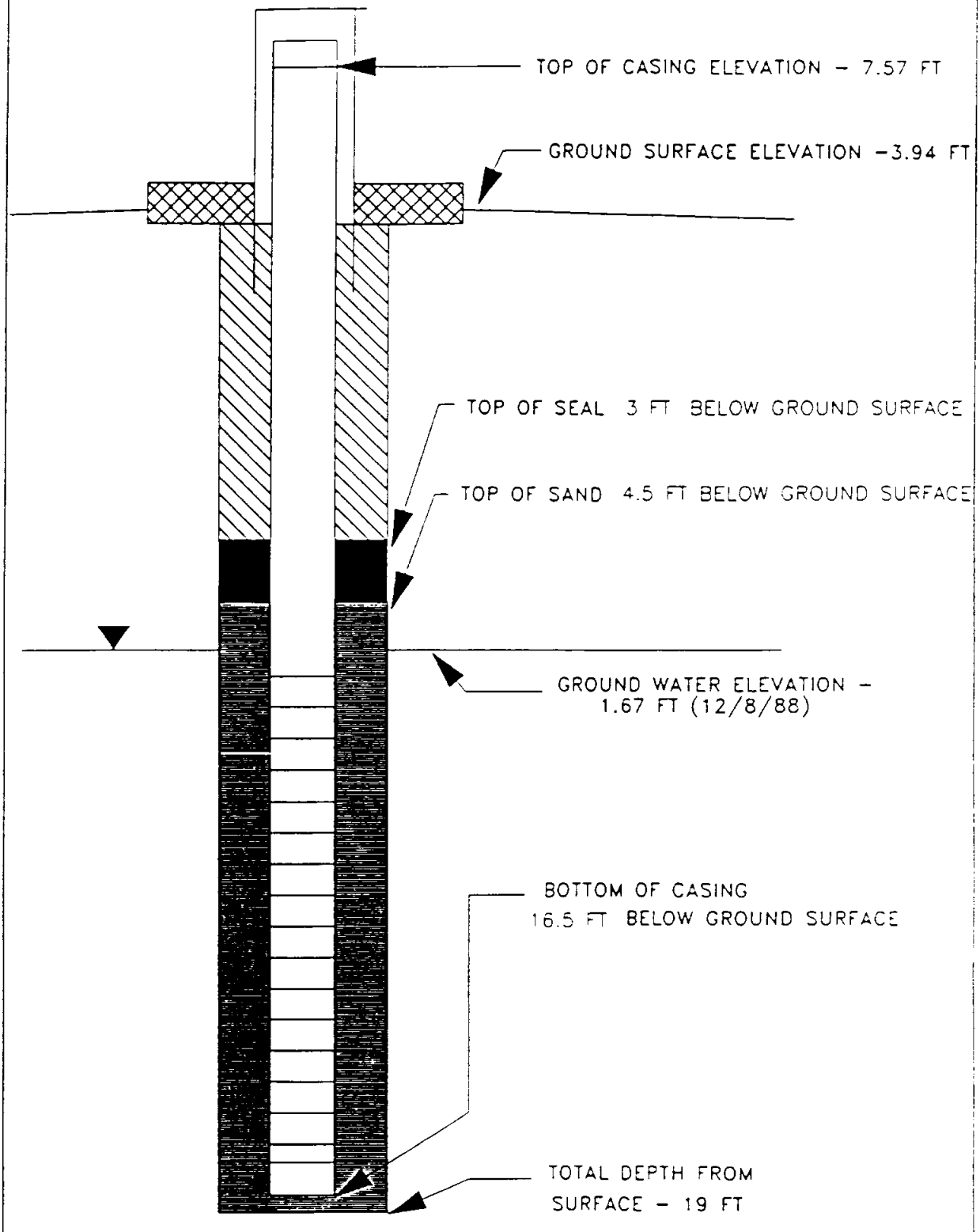
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

2MG07

WELL NUMBER - R2W-1

N - 566880.52
E - 1571081.71



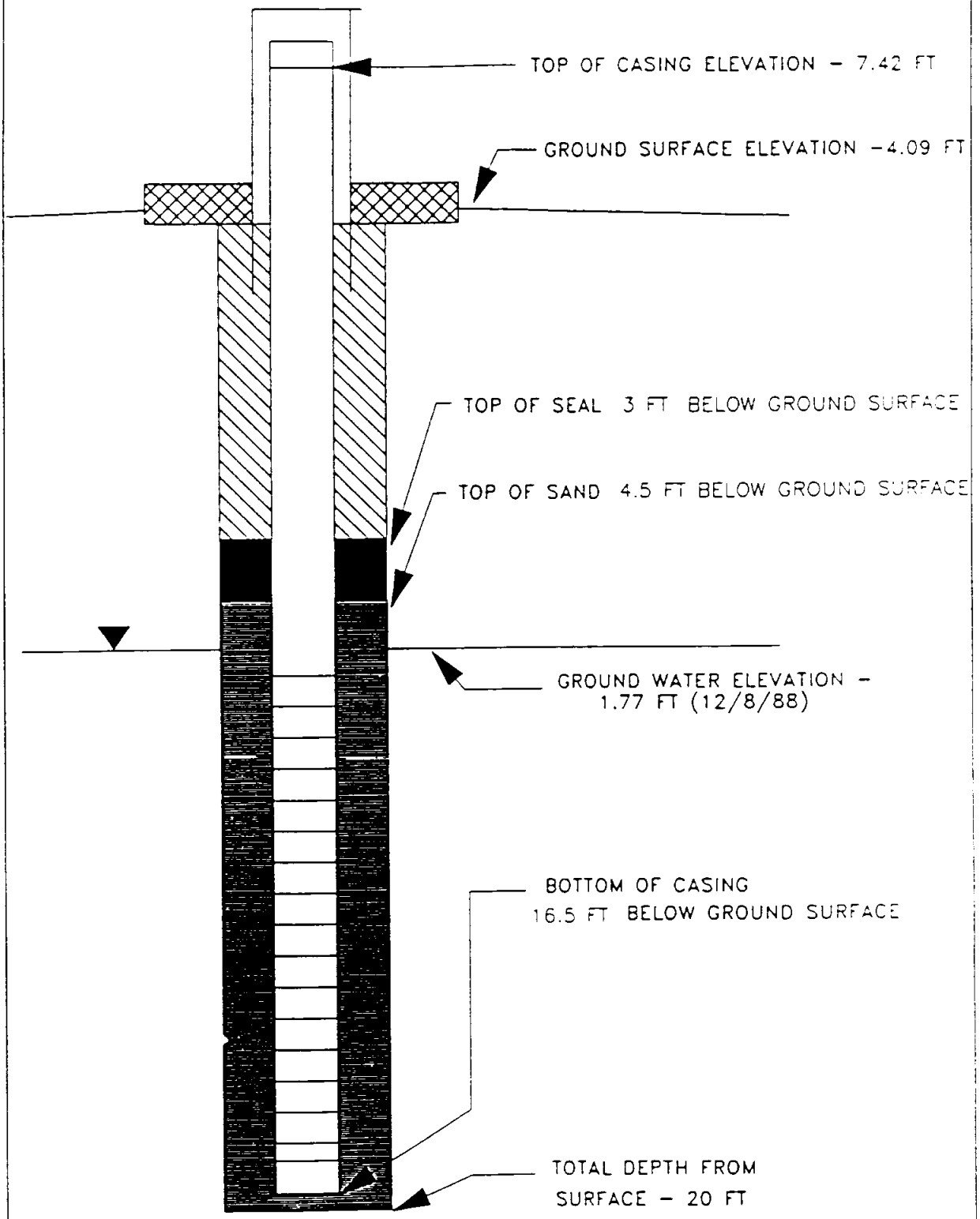
PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

2AG08

WELL NUMBER - R2W-2

N - 566820.16
E - 1570699.91



PROJECT:	NAVAL WEAPONS STATION CONCORD
LOCATION:	CONCORD, CALIFORNIA
CLIENT:	MARTIN MARIETTA ENERGY SYSTEMS, IN.
DOE CONTRACT NO.:	DE-AC05-890R21400
IT PROJECT NO.:	409619/409769
DRILLING CO:	DATUM EXPLORATION, INC.

INTERNATIONAL TECHNOLOGY CORPORATION

2AG09

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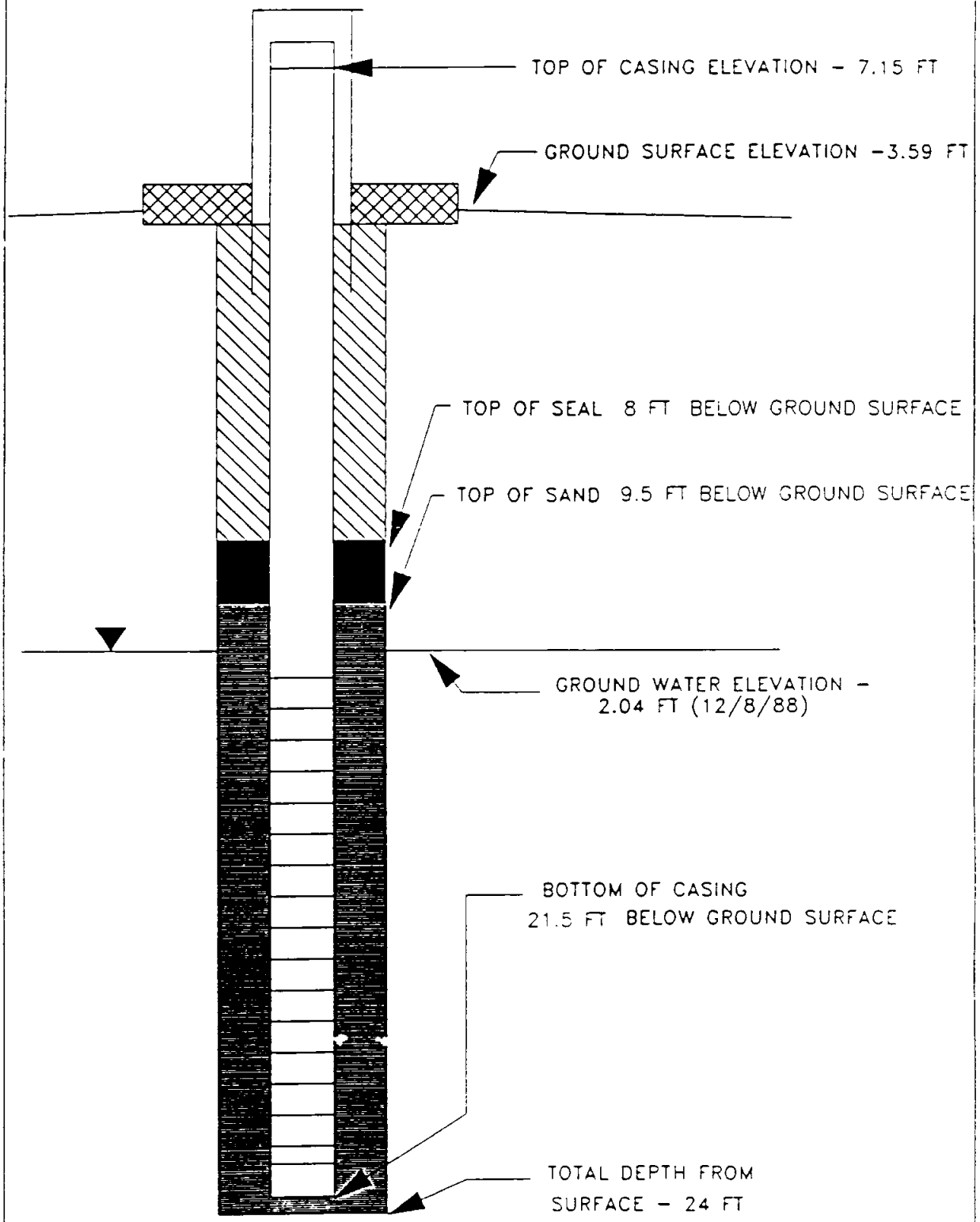

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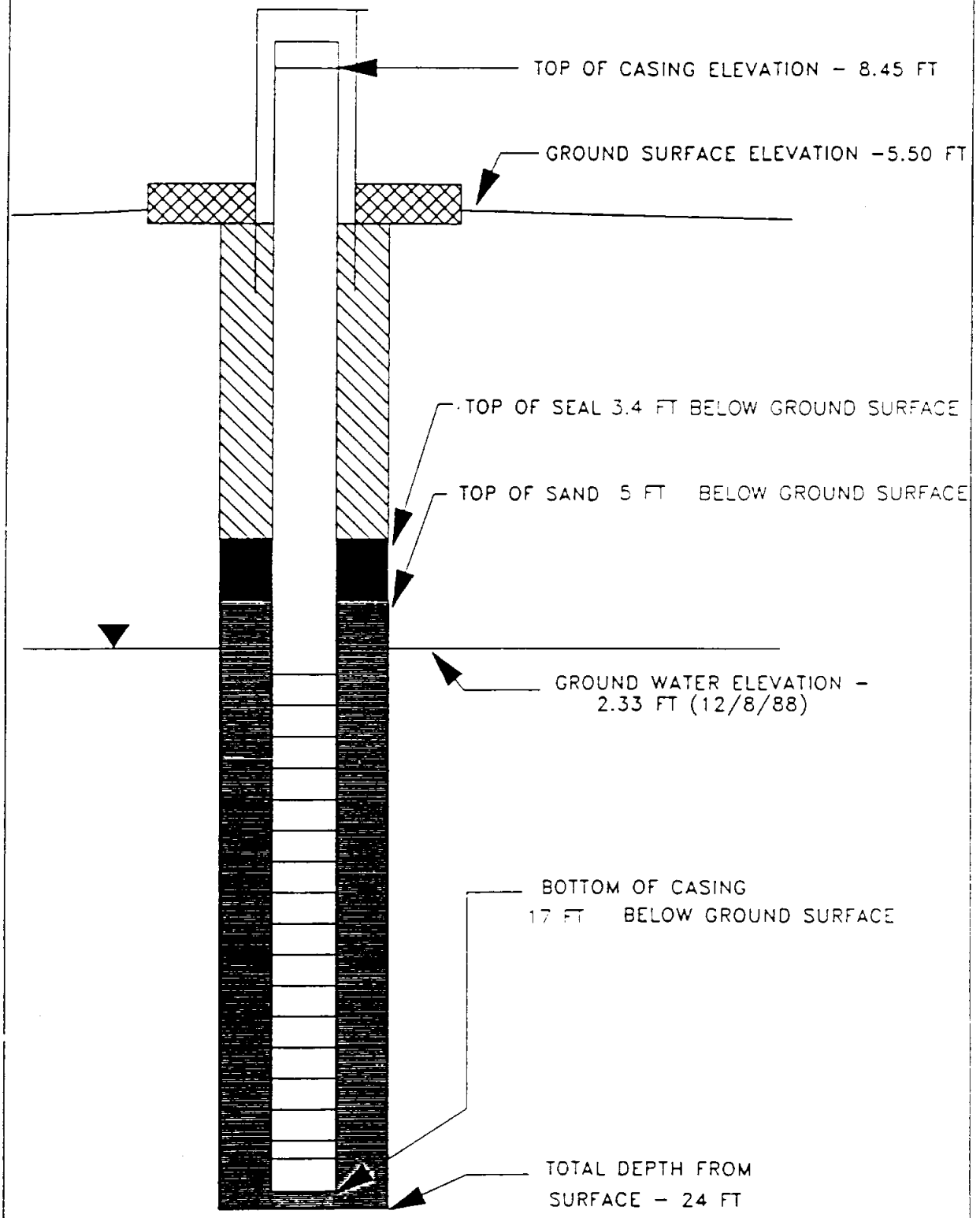

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3AG 11

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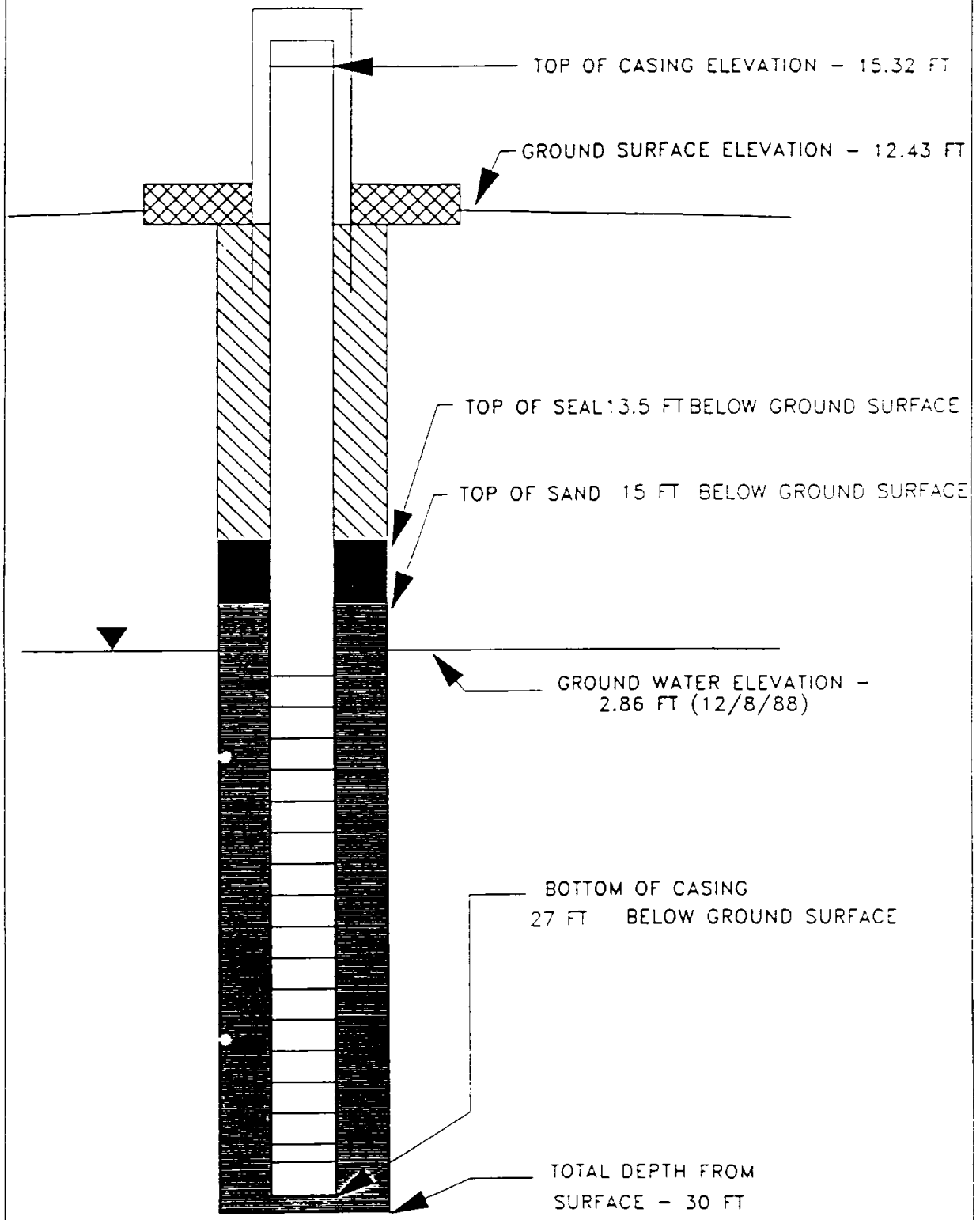

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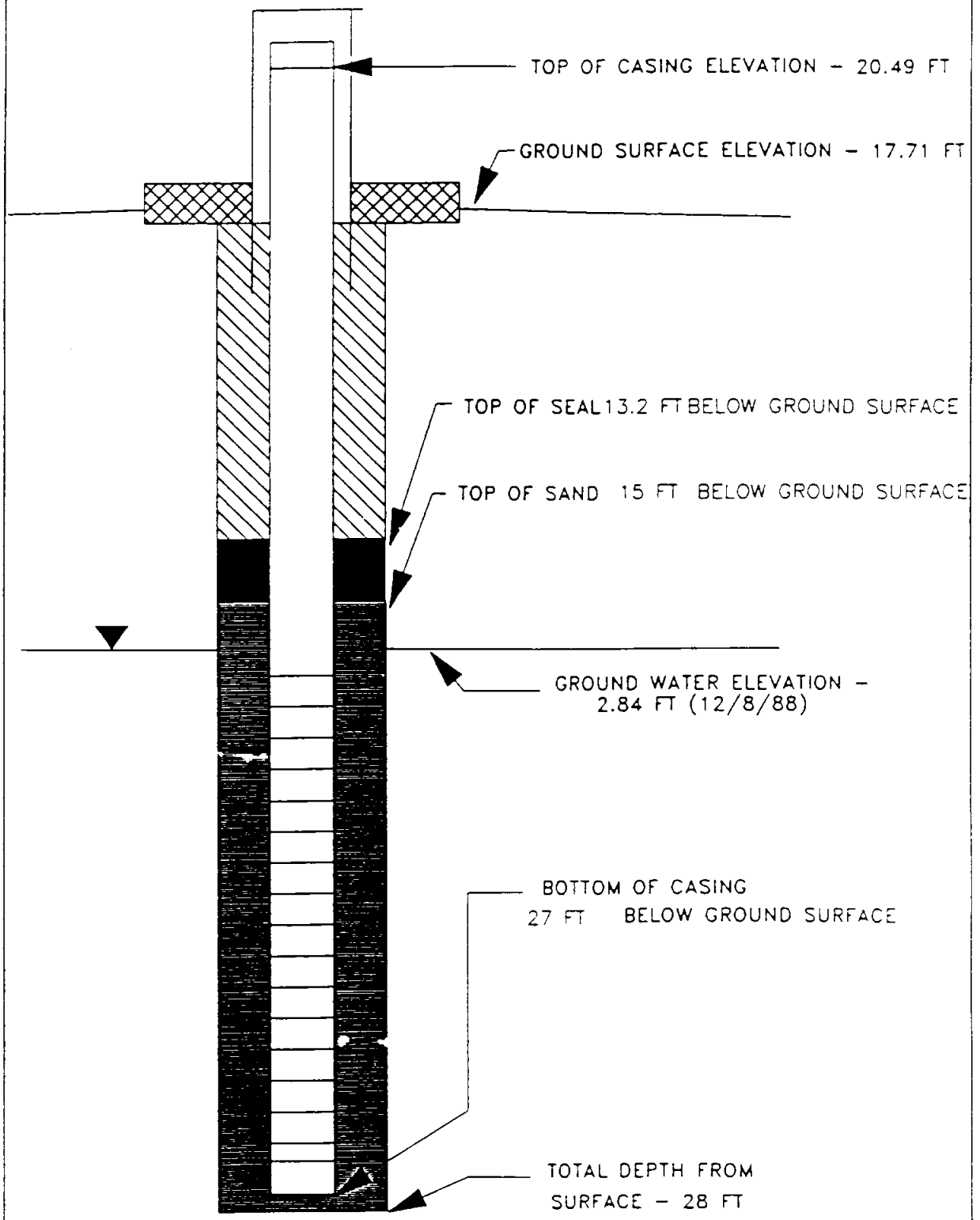

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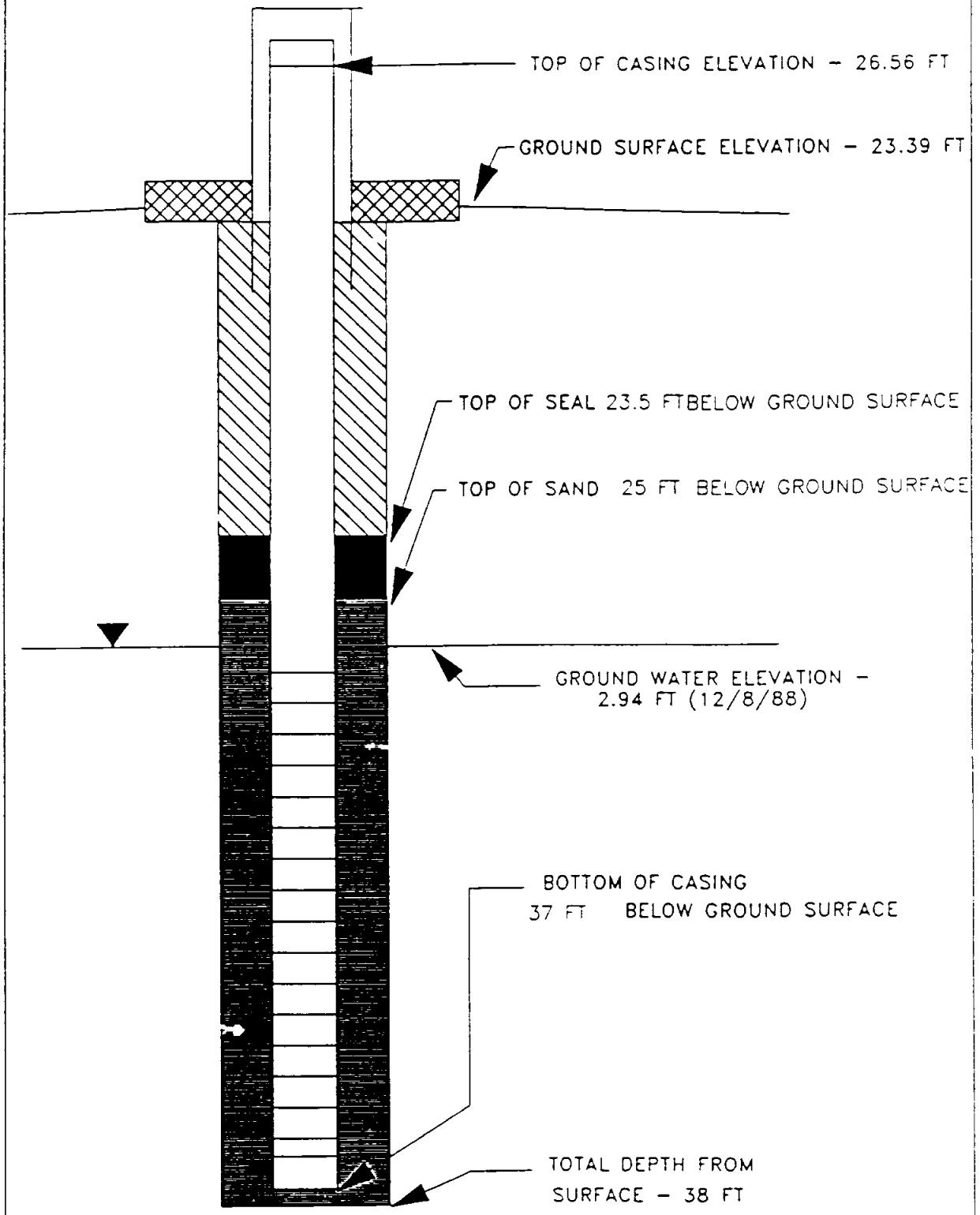

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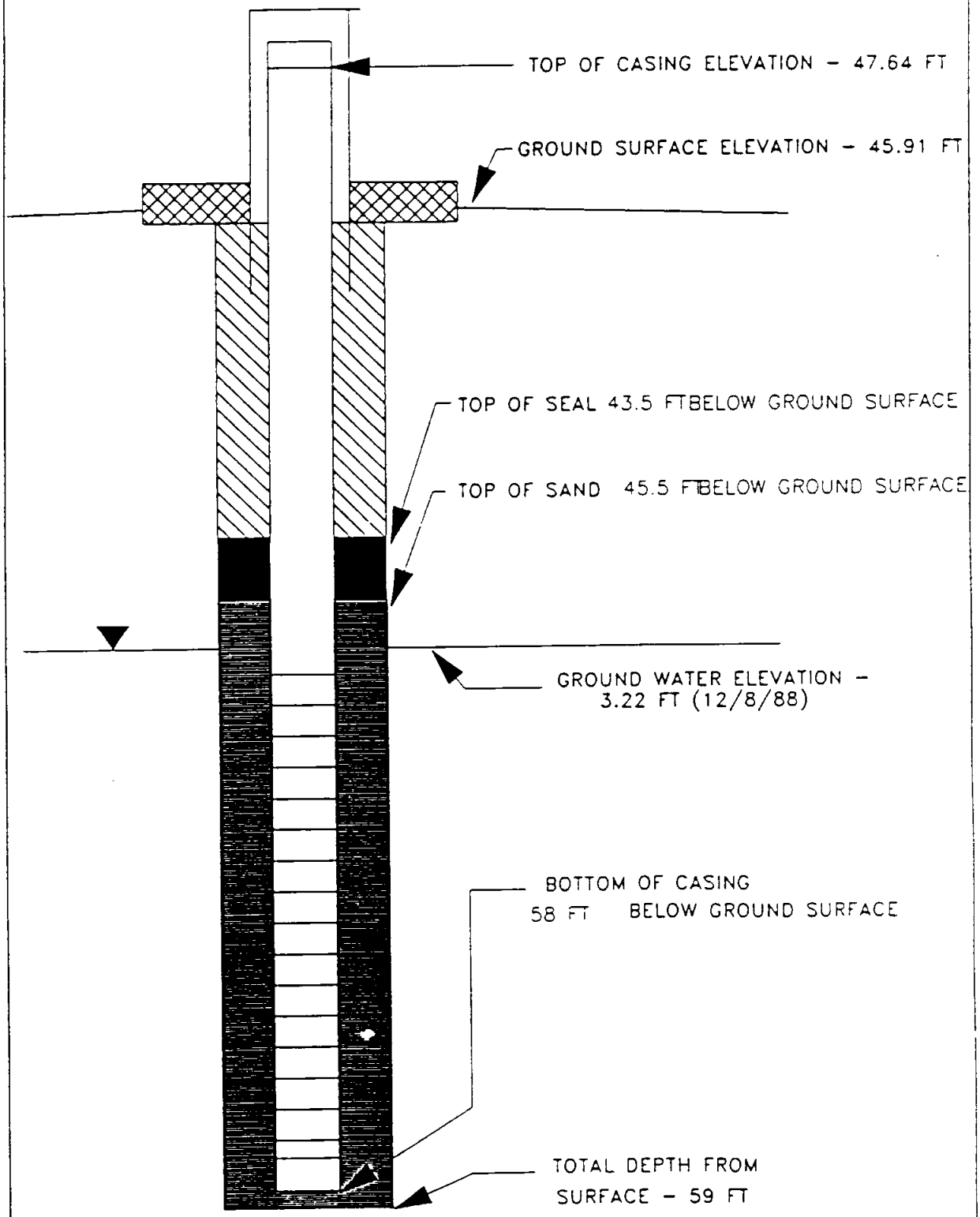

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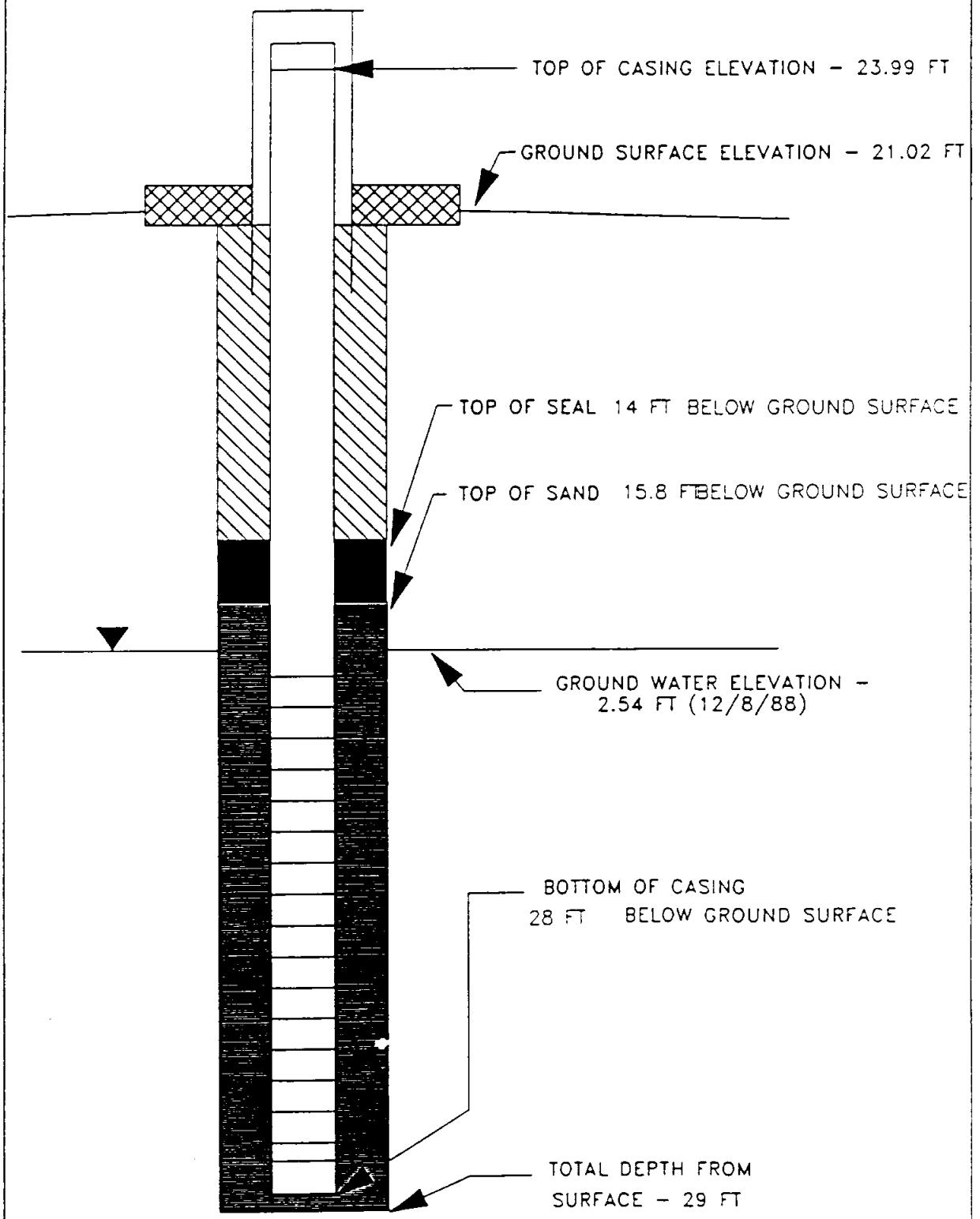

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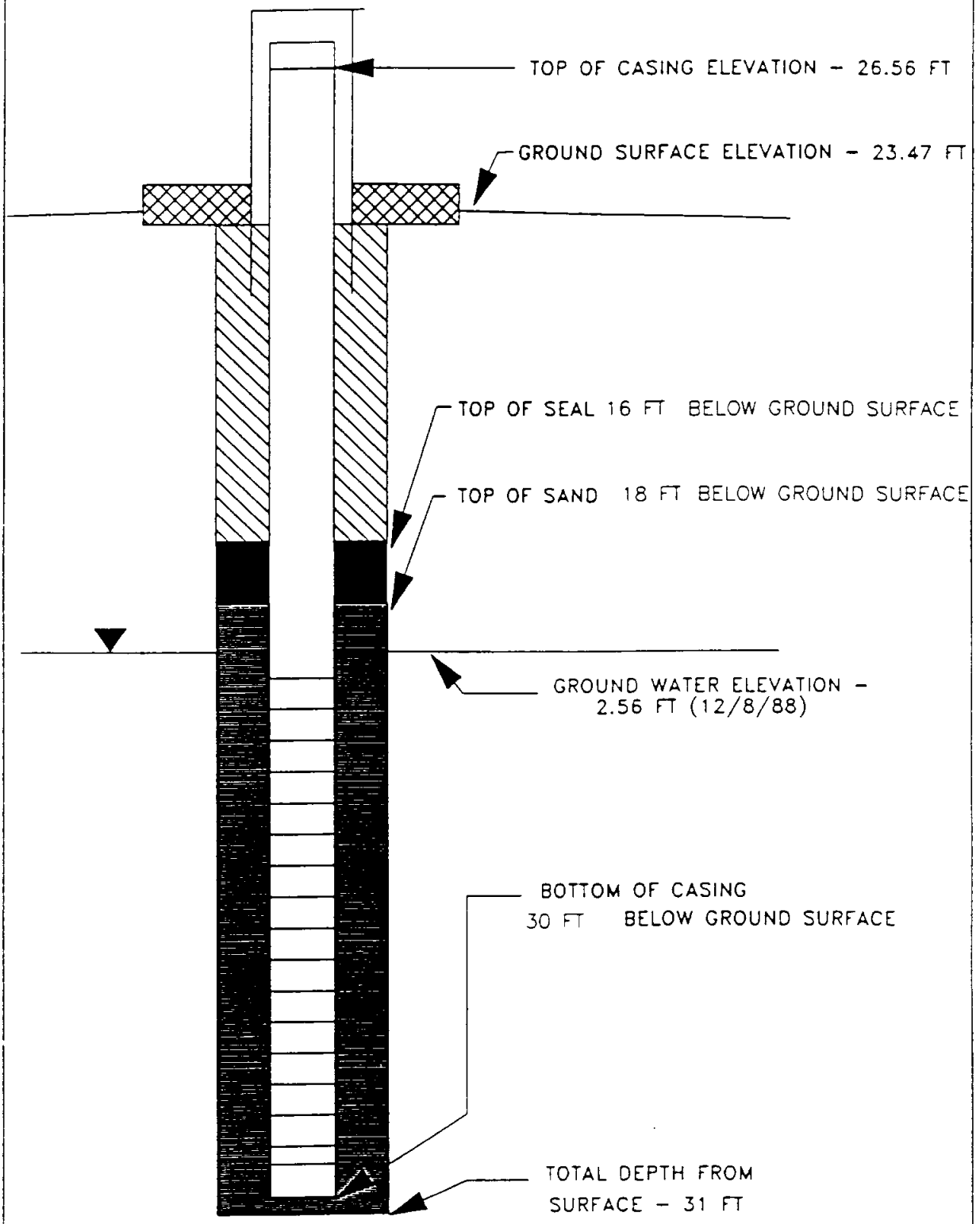

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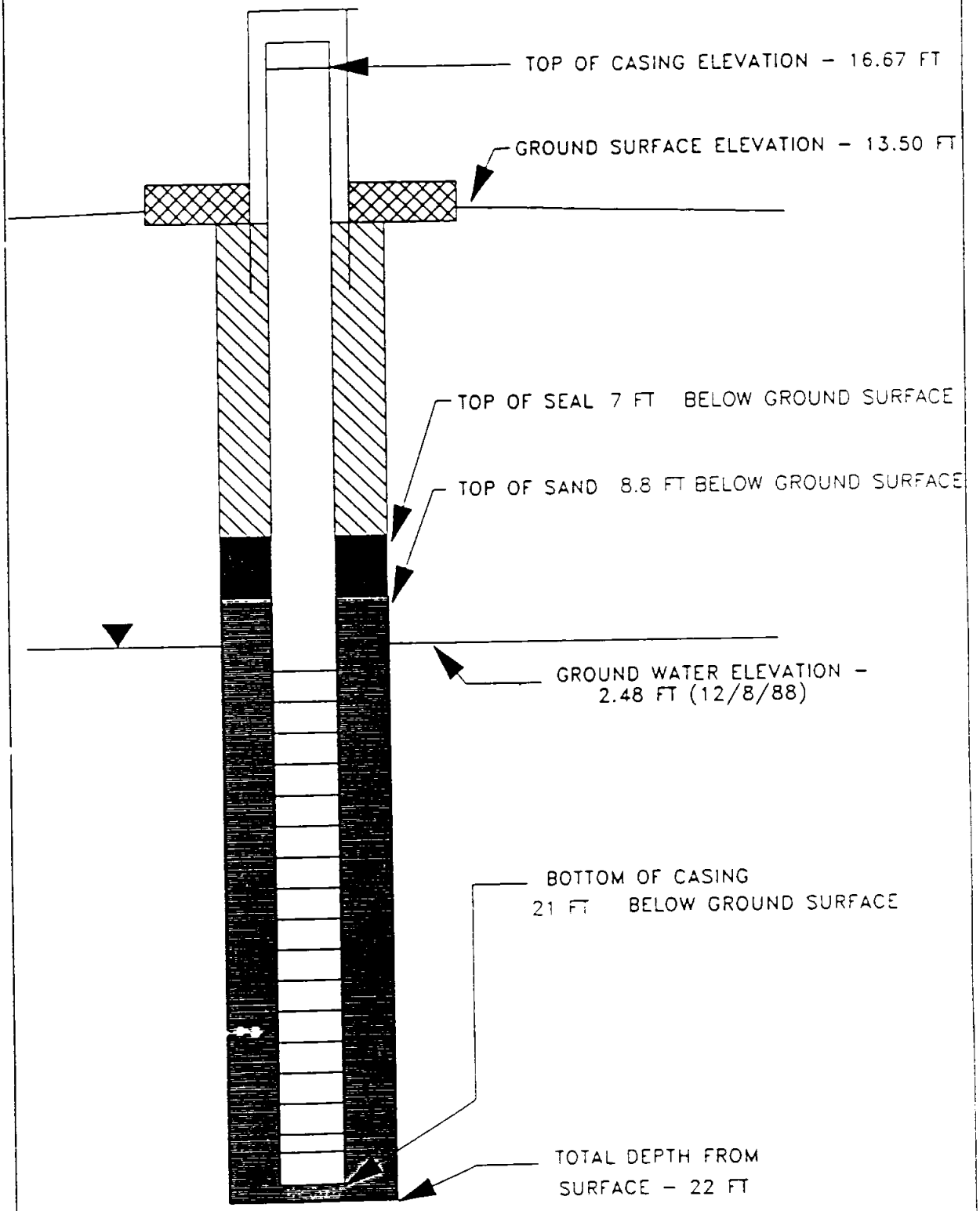

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IT PROJECT NO.:	409619/409769
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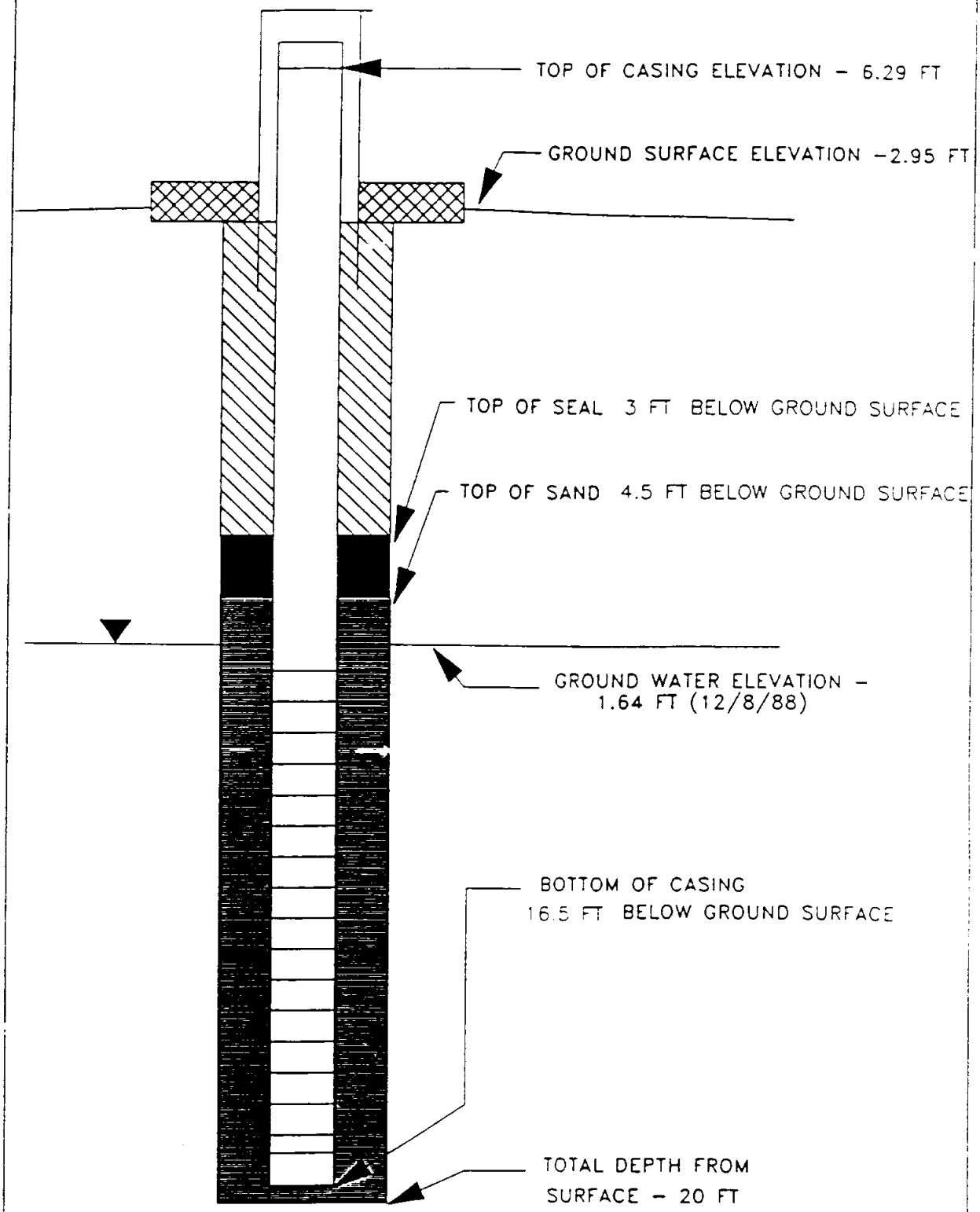

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IT PROJECT NO.:	409619/409769
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APPENDIX F

HUMAN HEALTH RISK ASSESSMENT FOR THE LITIGATION AREA FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

(68 Pages)

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ABBREVIATIONS AND ACRONYMS

bgs	Below ground surface
Cal/EPA	California Environmental Protection Agency
CCCMVAD	Contra Costa County Mosquito and Vector Abatement District
CLP	Contract Laboratory Program
COPC	Chemical of potential concern
cm^3	Cubic centimeters
CSM	Conceptual site model
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DL	Detection limit
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
E&E	Ecology and Environment, Inc.
EFA WEST	Naval Facilities Engineering Command, Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
Five-year review	Five-year periodic review assessment
FS	Feasibility study
HHRA	Human health risk assessment
HQ	Hazard quotient
HI	Hazard index
IAS	Initial assessment study
IT	International Technology Corporation
m^3	Cubic meters
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram body weight per day
µg/L	Microgram per liter
Navy	U.S. Department of the Navy
NCEA	National Center for Environmental Assessment
NRC	National Research Council
NWSSBD	Naval Weapons Station, Seal Beach Detachment
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal

ABBREVIATIONS AND ACRONYMS (Continued)

QEA	Qualitative ecological assessment
RAP	Remedial action plan
RASS	Remedial action subsite
RBC	Risk-based concentration
RfD	Reference dose
RI	Remedial investigation
RME	Reasonable maximum exposure
RDA	Recommended daily allowance
SF	Slope factor
SVOC	Semivolatile organic compound
TDS	Total dissolved solids
TtEMI	Tetra Tech EM Inc.
VOC	Volatile organic compound

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Engineering Field Activity West (EFA WEST), conducted the first postremediation five-year periodic review assessment (five-year review) at the Litigation Area sites at Naval Weapons Station, Seal Beach Detachment (NWSSBD) Concord (Figure 1). The four remedial action subsites (RASS) were the focus of the review (Figure 2). The Navy authorized Tetra Tech EM Inc. (TtEMI), formerly PRC Environmental Management, Inc. (PRC), to conduct this review under the Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609, Contract Task Order No. 373. As part of this review, the Navy conducted a human health risk assessment (HHRA) to evaluate potential risks associated with exposure to contaminants detected in soil, sediment, and surface water at the Litigation Area sites.

A remedial investigation (RI) was completed in January 1986 for the sites collectively known as the Litigation Area (Lee and others 1986, 1988). A quantitative HHRA was not conducted as part of the RI or other site investigations at the Litigation Area, which focused primarily on impacts to ecological receptors. Based on the findings of the RI and supporting studies, the Navy completed four remedial actions to address environmental concerns identified at the Litigation Area, as described in Section 4.0 of the five-year review report. Some contamination was left in place to minimize habitat destruction. The remedy therefore included active remediation of the most contaminated portion of each RASS and passive remediation and monitoring of the remaining portion of each RASS. The HHRA presented in this appendix evaluated the postremediation or current conditions. Following remediation, a five-year annual monitoring program was established and a qualitative ecological assessment (QEA) (PRC 1997b) was conducted to evaluate potential risks to ecological receptors associated with contamination remaining following the remedial actions. The HHRA presented in this appendix was based on the site characterization and sampling data from these investigations.

1.1 RISK ASSESSMENT OBJECTIVES

The HHRA for the Litigation Area was conducted to provide risk managers with an evaluation of the protectiveness of the remedy and a basis for evaluating whether additional action is warranted to mitigate potential health effects from exposure to contaminants in soil, sediment, or surface water at the Litigation Area sites. This assessment was accomplished by characterizing potential risks of cancer and adverse noncancer health effects associated with contaminants at the Litigation Area, under both current and potential future site conditions assuming no additional remedial actions.

1.2 RISK ASSESSMENT APPROACH

The approach for the Litigation Area HHRA was developed in consultation with the U.S. Environmental Protection Agency (EPA) and California Environmental Protection Agency (Cal/EPA), Department of Toxic Substances Control (DTSC) during a conference call on March 30, 2000, and a meeting held on May 2, 2000. That HHRA approach was presented in the work plan developed for the five-year review (TtEMI 2000b).

The HHRA evaluates current conditions at the Litigation Area under the assumption that no remedial actions (beyond those currently in place) will be implemented for existing chemical contamination. Risks to potential receptors identified based on current and possible future land use scenarios were evaluated. NWSSBD Concord is an active naval base and is not scheduled to close, so future land use at the Litigation Area sites is not expected to change from current use. The primary receptor identified under current and expected future land use conditions is a worker present intermittently at the Litigation Area. EPA and DTSC requested that commercial/industrial worker and resident receptors also be evaluated to provide information to support decisions on the need for restrictions if land use were to change in the future. Further, the regulatory agencies requested that the risks associated with exposure to soil, sediment, and surface water be evaluated separately for each sampling location within the Litigation Area.

To implement this approach, cancer risks and noncancer health hazards were evaluated under the following two-tiered approach:

- Tier 1 – Preliminary Remediation Goals (PRG) Screen. Risks to residential and industrial worker receptors were evaluated by comparing detected concentrations of each contaminant in soil and sediment with EPA Region 9 residential and industrial PRGs for soils (EPA 2000). Surface water concentrations were compared with tap water PRGs. The PRGs were used to estimate cancer risks and hazard indices (HI) (a measure of noncancer health effects) at each sampling location for soil, sediment, and surface water. The Tier 1 PRG screen evaluated risks to potential receptors under the unlikely assumption that land use at the Litigation Area may change in the future.

- Tier 2 – Risk-Based Concentration (RBC) Screen. Risks to site-specific receptors, identified on the basis of current land use at the Litigation Area, were evaluated by developing receptor-specific RBCs for soil, sediment, and surface water. The RBCs were used to estimate cancer risks and HIs at each soil, sediment, and surface water sampling location.

Groundwater at NWSSBD Concord is not suitable for use as a drinking water source because of the low hydraulic conductivity of the aquifer; the high concentrations of total dissolved solids (TDS), chloride, and iron; and the hardness of the water (discussed further in Appendix E). Groundwater was therefore not evaluated in the HHRA.

Detailed descriptions of the methods used to implement the Tier 1 PRG screen and Tier 2 RBC screen are presented in Sections 3.0 and 4.0.

1.3 APPENDIX ORGANIZATION

The remainder of this appendix is organized as follows. Section 2.0 presents background information on NWSSBD Concord and the Litigation Area. Section 3.0 presents the methodology and results of the Tier 1 PRG screen, and Section 4.0 presents the methodology and results of the Tier 2 RBC screen. The summary and conclusions of the HHRA are presented in Sections 5.0 and 6.0. Rather than presenting the cited figures and tables within this appendix, they are presented in separate sections following the main body of the five-year review report.

2.0 SITE DESCRIPTION AND BACKGROUND

NWSSBD Concord is in north-central Contra Costa County, approximately 30 miles northeast of San Francisco, California (Figure 1). The Navy facility operates an ocean-shipping terminal to transfer ordnance between trucks or railcars and ships. The facility is bounded on the north by Suisun Bay, on the south and west by the city of Concord (population 121,000), and on the east by private land and the city of Pittsburg. The facility encompasses nearly 13,000 acres in three holdings: Inland Area, Tidal Area, and a radiography facility at Pittsburgh, California. The Litigation Area is within the Tidal Area.

The Tidal Area comprises property on the mainland (6,077 acres) and islands (1,571 acres). Approximately 3,230 acres in the Tidal Area are leased for agricultural purposes (International Technology Corporation [IT] 1989). In the late 1960s and early 1970s, the Navy purchased several parcels of land to create a buffer zone around its munitions-loading operations. It was subsequently determined that eight of those parcels, which cover a total of approximately 307 acres, were contaminated, as described in Section 3.0 of the five-year review report. Because the Navy was involved in extensive litigation with adjacent property owners to recover remediation costs for these contaminated parcels, the parcels are now referred to as the "Litigation Area." The parcels were grouped into four RASSs of varying size (Figure 2). The RASSs are described briefly in Section 3.2.1 of this appendix, and additional information on the history and physical setting of the Litigation Area sites is provided in Section 2.0 of the five-year review report.

The Navy has conducted numerous investigations at the Litigation Area to evaluate the nature and extent of contamination. The investigations included the initial assessment study (IAS) (Ecology and Environment, Inc. [E&E] 1983), RI (Lee and others 1986, 1988), feasibility study (FS) (Cullinane and others 1988), preremediation monitoring (PRC 1994), postremediation monitoring (PRC 1996, 1997a;

TtEMI 1998, 1999a, 2000a), QEA (PRC 1997b), and the October 2000 field investigation to fill data gaps. Sections 3.0, 4.0, and 5.4 of the five-year review report present a detailed chronology of these investigations and summarize the investigation results.

Development of a conceptual site model (CSM) is an important component of both human health and ecological risk assessments; the CSM defines the exposure pathways to be evaluated in the risk assessments and provides other key information about contaminant sources and release and transport mechanisms. Detailed CSMs to support the ecological risk assessment for each of the four RASSs were developed in the draft final work plan (TtEMI 2000b) based on consultation between the Navy and regulatory and trustee agencies; these RASS-specific CSMs show sources, transport pathways, and ecological exposure routes (Figures 16, 17, 18, and 19). A HHRA sitewide CSM integrated the information from each of the RASS-specific models (Figure 15). The HHRA sitewide CSM provides details about historical sources and release mechanisms, current sources and release mechanisms, receiving and affected media, and exposure pathways and receptors. A discussion of the exposure pathways and receptors specific to the HHRA is presented in Section 3.2.

3.0 TIER 1 PRELIMINARY REMEDIATION GOALS SCREEN

The Tier 1 PRG screen used a streamlined approach to estimate cancer risks and HIs based on the ratio of detected contaminant concentrations to EPA Region 9 PRGs. This approach is outlined by EPA in its memorandum on deriving PRGs (EPA 2000) and by DTSC in its memorandum on the use of PRGs for screening-level assessments at military facilities (DTSC 1994).

PRGs are risk-based concentrations that correspond to a cancer risk of 1×10^{-6} or a hazard quotient (HQ) of 1, based on standardized equations that combine default exposure assumptions and EPA toxicity values (EPA 2000). PRGs have been developed for residential exposure to soil, commercial/industrial exposure to soil, and residential exposure to tap water. (PRGs are also available for ambient air but were not used in this HHRA.) Exposure pathways evaluated in the development of PRGs for soil were incidental ingestion, dermal contact, and inhalation of airborne particles. For tap water, the exposure pathways were ingestion and inhalation of volatile organic compounds (VOC) released into air during household use of water. The risk estimates developed using PRGs represent the risk for all exposure pathways evaluated within the soil or tap water PRG. A more detailed description of the approach and the equations used to calculate cancer risks and HIs using PRGs are presented in Section 3.4.

Although PRGs were used as a calculational tool to estimate cancer risks and HIs, the Tier 1 PRG screen followed the same four-step process used in conventional baseline risk assessments (EPA 1989). The

remainder of this section is organized to reflect these four basic steps as follows: Section 3.1 presents an evaluation of the data and selection of chemicals of potential concern (COPC) for evaluation in the HHRA, Section 3.2 is the exposure assessment, Section 3.3 is the toxicity assessment, Section 3.4 presents the risk characterization methodology, Section 3.5 presents the risk characterization results, and Section 3.6 presents a discussion of the uncertainties associated with the risk assessment.

3.1 DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

This section summarizes information about the identification and evaluation of analytical data used in the Tier 1 PRG screen. The selected data provide the basis for identifying site COPCs and estimating exposure point concentrations (EPC).

3.1.1 Data Evaluation

The first step of the data evaluation process was to identify the analytical data set for the HHRA. As previously discussed in Section 2.0, investigations have been conducted at the Litigation Area to support a variety of studies, including the IAS (E&E 1983), RI (Lee and others 1986, 1988), FS (Cullinane and others 1988), preremediation (PRC 1994) and postremediation monitoring events (PRC 1996, 1997a; TtEMI 1998, 1999a, 2000a), QEA (PRC 1997b), and the October 2000 field investigation to fill data gaps (the investigation results are presented in Section 5.4 of the five-year review report). Historically, the primary focus of these studies was metals contamination, although the QEA included an investigation of possible contamination by organic compounds. While several investigations were conducted to identify and delineate chemical contamination, the objectives of many of the investigations were to collect data to support assessments of impacts to ecological receptors and not human receptors. In addition, remedial actions conducted at RASSs 1 through 4 resulted in the excavation of areas represented by the sampling events in earlier studies. For these reasons, the data collected for each investigation were evaluated separately for usability in the HHRA. On the basis of that review, the analytical results from the 5 years of postremediation monitoring (PRC 1996, 1997a; TtEMI 1998, 1999a, 2000a) and the QEA (PRC 1997b) were identified as appropriate for the HHRA.

Following remediation, TtEMI began a five-year annual monitoring program that included collection of soil, sediment, and surface water samples for chemical analysis. Statistical methods were used to determine the number of samples necessary to address monitoring objectives. The Litigation Area was divided into 16 spatial units (Figure 12), which were overlain by a 100-by-100-foot sampling grid. Priorities were established for sampling of the spatial units on the basis of the level of concern about concentrations of contaminants. For soil, a different sampling location within each grid area was

randomly chosen for each of the five years of monitoring. For sediment and surface water, the same location within each grid area was sampled each year. Surface soil samples (0 to 0.5 feet below ground surface [bgs]) were analyzed for six metals of concern identified in the RI: arsenic, cadmium, copper, lead, selenium, and zinc. Soil, sediment, and surface water samples collected in RASS 4 were also analyzed for mercury. (Appendix D provides a detailed description of the five-year monitoring program.) For the HHRA, the maximum detected concentration in the soil, sediment, and surface water sampling locations within each 100-by-100-foot grid collected over the five-year monitoring period was used to represent the grid area.

The QEA was conducted from 1995 through 1997 with the objective of evaluating whether contamination remaining following the remedial actions presented a significant risk to ecological receptors. As part of the QEA, a total of 67 soil samples, 99 sediment samples, and 29 surface water samples were collected at the Litigation Area sites. These samples were analyzed for metals, semivolatile organic compound (SVOC), pesticides, and polychlorinated biphenyls (PCB). A few soil samples in RASS 3 were analyzed for VOCs. Soil and sediment samples were collected to a depth of 18 inches bgs, and at some locations, both surface (0 to 6 inches bgs) and subsurface (12 to 18 inches bgs) samples were collected. The maximum concentration of each detected analyte at each sampling location was selected for the HHRA data set at locations where both surface and subsurface samples had been collected. Figure 13 shows the locations sampled for organic analytes during the characterization of nature and extent of contamination conducted for the QEA (PRC 1997b). Locations sampled for inorganic analytes were a subset of the Year 1 monitoring locations and are shown on Figure 12.

The subset of analytical data from the QEA and postremediation monitoring program selected for evaluation in the Tier 1 PRG screen is referred to as the HHRA data set. As described previously, the data set comprises the maximum detected concentration at each sampling location (or from within each grid) for each analyte. Tables 27 through 30 present statistical summaries of the HHRA soil and sediment data sets for each RASS. The analytical results for soil and sediment were combined for the Tier 1 PRG screen because human contact with soil and sediment may occur by the same mechanisms (see Section 3.2.3). The tables list all analytes detected at one or more locations, the number of locations at which the analyte was detected, the minimum and maximum detected concentrations in the data set, and the number of locations at which the detected concentration exceeded the residential PRG and the ambient limit. (Ambient limits for NWSSBD Concord are discussed in Section 3.1.2.1). Tables 31 through 34 present similar information for the surface water data sets; however, ambient limits have not been derived for surface water and ambient comparisons were not performed.

A rigorous data evaluation process was completed to verify that the quality of the sampling data was acceptable for risk assessment purposes. To summarize the data validation process, the entire data set was subject to a cursory review, and 10 percent of the data was fully validated. The overall objective of data validation was to ensure that the quality of the analytical data was adequate for their intended purpose, as defined by the following parameters: precision, accuracy, representativeness, completeness, and comparability. At each stage of validation, qualifiers were assigned to the results according to EPA guidelines (EPA 1994a, 1994b). Consistent with EPA guidance (EPA 1992), all data without qualifiers and all data qualified as estimated (J) were used in the risk assessment. Data qualified as rejected (R) were considered unusable for the risk assessment.

Data qualified as not detected (U) were also excluded from the analysis because of the point-by-point evaluation conducted. That is, the concentration terms used in the assessment were the detected concentrations at each sampling location. To address the potential impacts of the nondetected results on the assessment, sample detection limits (DL) were compared with soil and surface water PRGs for residential land use (EPA 2000). The purpose of this comparison was to identify analytes with DLs greater than their health-based PRG; such analytes could be present at concentrations that represent a health risk, even though they were reported as not detected. This comparison, and a discussion of the findings, is presented in Section 3.6.2.

3.1.2 Selection of Chemicals of Potential Concern

COPCs are those chemicals included in the quantitative exposure assessment and risk characterization steps of the HHRA. COPCs were selected separately for (1) soil and sediment and (2) surface water, two of the three exposure media evaluated quantitatively in the risk assessment (see Section 3.2). COPCs were not identified separately for air, because within the PRG framework, COPCs in air are assumed to be the same as those identified for soil and sediment. That is, soil and sediment are the source of COPCs in air, released from soil as airborne soil particles or as vapors.

3.1.2.1 Soil and Sediment

All organic analytes detected in soil and sediment were selected as COPCs. Detected inorganic analytes were retained as COPCs if the following conditions applied:

- The compound was not an essential human nutrient (EPA 1989)
- The detected concentration exceeded the established ambient concentration

These screening criteria are discussed in the following subsections.

Essential Nutrient Screen

Elements considered essential human nutrients (that is, calcium, iron, magnesium, potassium, and sodium) were eliminated as COPCs. EPA (1989) and DTSC (1992) guidance recommends eliminating these elements as COPCs because of their low toxicity when detected at ambient concentrations. Even if these chemicals were present at concentrations above naturally occurring levels, they were eliminated as COPCs because they are toxic only at very high doses. The one exception is iron, as discussed below.

During the May 2, 2000 meeting to discuss the risk assessment approach, EPA and DTSC requested that a qualitative assessment of health impacts from exposure to iron be presented in the assessment. This is because U.S. EPA has issued a provisional reference dose (RfD) for iron, and EPA Region 9 has developed a PRG for iron based on the provisional RfD. The qualitative risk evaluation of iron is presented in the uncertainties discussion in Section 3.6.

Ambient Screen

EPA (1989) and DTSC (1992) recommend that metals detected at ambient limits (also known as background metals concentrations) be eliminated as COPCs at a site. The elimination of ambient metals is also consistent with Navy policy, which states that risk assessments should not be conducted on metals present at naturally occurring levels (Navy 2000). Ambient limits in soils were previously estimated to support the RIs at the Tidal Area and Inland Area sites at NWSSBD Concord (Table 35). Ambient data sets were developed for the following three areas: (1) Tidal Area (TtEMI 1999b), (2) Inland Area Sites 13 and 22 (shallow sediments of alluvial/estuarine origin) (TtEMI and Montgomery Watson 1997), and (3) Sites 17 and 24A (materials eroded and deposited in the vicinity of Los Medanos Hills) (TtEMI and Montgomery Watson 1997). Metals in RASSs 1 and 2 were screened against the Tidal Area data set, and metals in RASSs 3 and 4 were screened against the Sites 17 and 24A ambient data set. The selection of the ambient data set for screening was based on consideration of the predominant soil type within each RASS. The ambient limit used for screening in the Tier 1 PRG screen was the 95th percentile of the ambient data set distribution, as listed in Table 35.

For each metal with an established ambient limit, the maximum detected concentration at each sampling location was compared with its established ambient limit. This comparison was conducted for each sampling location. If the maximum detected concentration at a sampling location exceeded the ambient limit, the metal was retained as a COPC at that location. Conversely, if the maximum detected concentration was less than the ambient limit, the metal was eliminated as a COPC at that location. All

metals for which ambient limits have not been developed were retained as COPCs at locations where they were detected. A more rigorous statistical analysis of ambient conditions could not be conducted because of the point-by-point approach used for the assessment. Uncertainties associated with the ambient analysis are discussed in Section 3.6.

The COPCs selected for evaluation at one or more soil or sediment sampling locations within RASSs 1 through 4 are presented in Tables 27 through 30. As previously described in Section 3.1.1, statistical summaries of the analytical data are also presented.

3.1.2.2 Surface Water

Because ambient limits have not been established for metals in surface water at NWSSBD Concord, all detected analytes (other than essential nutrients) were retained as COPCs. As for soil and sediment, COPCs were identified separately for each sampling location.

The COPCs identified for surface water at RASSs 1 through 4 are presented in Tables 31 through 34. As previously described in Section 3.1.1, statistical summaries of the analytical data are also presented.

3.2 EXPOSURE ASSESSMENT

An exposure assessment includes a description of the exposure setting and land use, an evaluation of contaminant sources and release and transport mechanisms, identification of potentially exposed human receptors, selection of intake assumptions, estimation of EPCs, and estimation of daily intakes. As previously discussed in Section 2.0, a detailed evaluation of contaminant sources and release and transport mechanisms was conducted for the draft work plan (TtEMI 2000b), and this information was used to develop the HHRA sitewide CSM presented on Figure 15.

Several of the components of an exposure assessment have already been incorporated into the development of PRGs and were not performed specifically as part of this assessment. This section therefore focuses on the site-specific components of the exposure assessment and discusses the relationship of the likely receptors and exposure pathways at the Litigation Area sites to the receptors and pathways evaluated within the PRG framework.

3.2.1 Exposure Setting and Land Use

NWSSBD Concord is an active naval base and is not scheduled to close. The facility operates an ocean-shipping terminal to transfer ordnance between trucks or railcars and ships. The Litigation Area serves as a buffer zone surrounding the Tidal Area, which is leased for agricultural purposes. Because NWSSBD

Concord is not scheduled to close, future land use at the Litigation Area sites is not expected to change from current use.

As described in Section 2.0, the Litigation Area comprises RASSs 1 (210 acres), 2 (13 acres), 3 (71 acres), and 4 (13 acres) (Figure 2). Currently, RASS 1 is undeveloped tidal wetland that includes slough channels and a network of mosquito abatement ditches. RASS 2 is also undeveloped and includes tidal wetland and upland areas. RASS 3 consists of undeveloped land; it is primarily an upland area characterized by grassland that is bisected by a small seasonal stream (Nichols Creek) that empties into a wetland. RASS 4 is undeveloped grassland that includes a small nontidal wetland.

3.2.2 Identification of Receptors

The Tier 1 PRG screen evaluates residential and commercial/industrial receptors. Although NWSSBD Concord is an active base and future land use is not expected to change, EPA and DTSC requested that these receptors be evaluated to provide information to support decisions on the need for restrictions if land use were to change in the future. The residential scenario generally represents the greatest potential for exposure to site contaminants; therefore, sites or areas that pose acceptable risk under the residential scenario will also show acceptable risk for other uses, such as industrial or recreational use. For sites showing unacceptable risks, the risk results for the residential scenario provide information that supports risk management decisions about the need for possible restrictions on land use. Similarly, the results for the commercial/industrial worker provide information about potential risks to workers if land use were to change or the need for land use restrictions.

As previously discussed in Section 3.0, a resident and commercial/industrial worker are the two receptors evaluated within the PRG framework (EPA 2000). The exposure parameters used by EPA Region 9 to develop the commercial/industrial and residential PRGs are listed in Table 36.

3.2.3 Exposure Pathways

The primary exposure media at the Litigation Area sites are soil, sediment, and surface water. Because human contact with soil or sediment may occur by the same mechanisms, these media were combined for this assessment and no distinction was made between them.

The following exposure pathways for soil and sediment are evaluated for a resident and commercial/ industrial worker within the PRG framework (EPA 2000):

- Incidental ingestion of soil and sediment
- Dermal contact with soil and sediment
- Inhalation of airborne soil particles or vapors released from soil or sediment to ambient air

These exposure pathways are consistent with the potential exposure pathways of hypothetical future worker and resident receptors at the Litigation Area. One pathway not accounted for in the PRG framework is exposure from inhalation of vapors released from soil to indoor air. Since no structures are currently present at the Litigation Area and structures are not planned for the future, this pathway was not evaluated. The potential impact of excluding this pathway on the risk assessment results is discussed in the uncertainties evaluation in Section 3.6.

For surface water, EPA and DTSC requested that the Tier 1 PRG screen present risks based on a comparison of surface water concentrations to tap water PRGs. The exposure pathways evaluated within the PRG framework are as follows:

- Ingestion of water (that is, surface water is assumed to be a source of drinking water)
- Inhalation of VOCs released during household use

Surface water in the sloughs, ditches, and impoundments at NWSSBD Concord is not potable, so the Tier 1 screen for surface water yields extremely conservative estimates of potential risk. Risks based on exposure pathways more representative of potential exposures to surface water are evaluated in the Tier 2 screen, presented in Section 4.0.

As previously discussed in Section 1.2, groundwater at NWSSBD Concord is not suitable for use as a drinking water source because of the low hydraulic conductivity of the aquifer; the high concentrations of TDS, chloride, and iron; and the hardness of the water (as presented in Appendix E). Groundwater was therefore not evaluated in the HHRA.

3.2.4 Estimation of Exposure Point Concentrations

Separate EPCs were developed for each sampling location within the Litigation Area. As previously discussed in Section 3.1, the HHRA data set comprised a subset of the analytical data collected during the postremediation monitoring program (PRC 1996, 1997a; TtEMI 1998, 1999a, 2000a) and QEA (PRC 1997b) that included the maximum detected concentration from each soil, sediment, and surface water sampling location from these two studies. The maximum detected concentration at each sampling location was used as the EPC for that location.

3.3 TOXICITY ASSESSMENT

Cancer slope factors (SF) and RfDs are the toxicity values used to develop the EPA Region 9 PRGs. A complete list of these values is presented in the PRG table (EPA 2000).

The selection of PRGs used for the Tier 1 screen is discussed in Section 3.3.1, and the evaluation of lead is discussed in Section 3.3.2.

3.3.1 Preliminary Remediation Goals Used in the Tier 1 Screen

The PRGs used in the Tier 1 PRG screen were taken from an electronic file available online from EPA Region 9 (EPA 2000). For most compounds, only one soil PRG and one tap water PRG are listed in the main PRG table. More than one PRG is listed for some compounds in the electronic file. The following decision rules were applied to compounds with more than one PRG:

- PRGs with a "sat" notation. Two soil PRGs are available for some VOCs: a risk-based PRG and a "sat" PRG that corresponds to the soil saturation limit of the compound. The saturation limit is the predicted concentration at which the compound is expected to be present in free phase, as a nonaqueous phase liquid (for compounds that are liquid at ambient temperatures) or as a solid phase (for compounds that are solid at ambient temperatures). EPA requested that the "sat" PRG be used in the Tier 1 screen.

- PRGs with a "ceiling" notation. Two soil PRGs are available for some compounds of low toxicity: a risk-based PRG and a "ceiling" limit PRG concentration of 100,000 milligrams per kilogram (mg/kg). EPA assigns a ceiling limit when the risk-based concentration is greater than 100,000 mg/kg. EPA requested that the "ceiling" PRG be used in the Tier 1 screen.

- "Cal-modified" PRGs. The Cal/EPA has developed cancer SFs that for a few chemicals differ significantly from the EPA SFs. As a result, some chemicals have two PRGs, one developed using the EPA SF and the other based on the Cal/EPA SF. The Cal-modified PRGs are lower (more health protective) than the corresponding EPA Region 9 PRGs. DTSC requested that the "Cal-modified" PRGs be used for the Tier 1 PRG screen, where available.

- PRGs for carcinogens. For some carcinogens, separate PRGs are available to assess their carcinogenic effects and their noncarcinogenic effects (EPA 2000). For these compounds, both PRGs were used to evaluate cancer risks and noncancer health effects (that is, to calculate the HI).

Finally, PRGs have not been developed for some of the COPCs at the Litigation Area. A surrogate (substitute) PRG was selected to evaluate COPCs lacking a PRG. The selection of surrogate compounds was based on chemical structure.

Tables 37 and 38 list the soil and tap water PRGs used to conduct the Tier 1 screen. The listing identifies "sat" and "ceiling" PRGs, Cal-modified PRGs, and PRGs based on surrogate values.

3.3.2 Lead

The PRG for lead is based on blood-lead concentrations as the endpoint of concern. As a result, the soil PRG developed for lead does not correspond to a cancer risk or an HI. (A tap water PRG is not available for lead.) Lead was therefore evaluated separately from all other COPCs by comparing soil concentrations directly with the EPA Region 9 residential PRG of 400 mg/kg and to the industrial PRG of 750 mg/kg. The basis for the PRGs is summarized in the following text.

The EPA Region 9 residential PRG of 400 mg/kg was developed to protect children exposed to lead in a residential setting. The PRG is based on the results of an EPA analysis that used the "Integrated Exposure Uptake Biokinetic Model for Lead in Children" that estimates concentrations of lead in soil that correspond to a blood-lead concentration of 10 micrograms per deciliter as the threshold level of concern (EPA 1994c). The model reflects exposure to lead by ingestion of soil, dermal contact with soil, and inhalation of dusts from site-related sources; and by ingestion of water and food, and inhalation of air from background sources.

EPA Region 9 developed the industrial PRG to protect the fetus of a woman exposed to lead in a nonresidential setting, including commercial and industrial exposures. The fetus is more sensitive to the adverse health effects of lead than an adult; as a result, a PRG that is protective of a fetus should also afford protection for an adult. The EPA Region 9 industrial PRG is based on the results of an EPA analysis that used a model (referred to as the adult lead model) to calculate soil lead concentrations corresponding to a fetal blood-lead concentration of 10 micrograms per deciliter, the threshold level of concern (EPA 1996). The model reflects exposure from site-related and background sources. The site-related exposures assume frequent and regular occupational exposure and are based on incidental ingestion of soil and dust. Although workers might also be exposed through dermal contact with soil and inhalation of airborne dusts, EPA's analysis indicated that lead uptake from these pathways is insignificant relative to the ingestion pathway, so they are not quantitatively evaluated in the model. Soil lead concentrations ranging from 750 to 1,750 mg/kg are obtained from the model depending on the assumptions used. This range results from variation in the model input parameters such as inter-individual and population variability, lead concentrations in drinking water, and lead bioavailability (EPA 1996). Based on the model results, Region 9 established a lead PRG of 750 mg/kg as protective of human health in an occupational setting.

3.4 RISK CHARACTERIZATION METHODOLOGY

The risk characterization step estimates the potential excess lifetime cancer risk and calculates an HI to quantify the potential for adverse health effects other than cancer for resident and commercial/industrial worker receptors potentially exposed to COPCs in soil, sediment, and surface water. The PRG-based methodology for estimating cancer risks and HIs is presented Sections 3.4.1 and 3.4.2, and the approach for evaluating the health effects from exposure to lead is presented in Section 3.4.3.

3.4.1 Estimation of Excess Lifetime Cancer Risks

PRGs are typically used as a screening tool to qualitatively assess the potential risk to human health associated with exposure to a single contaminant in a single environmental medium (soil, water, or air). PRGs can also be used to develop quantitative estimates of the cancer risks associated with exposure to multiple contaminants in multiple media. The approach is outlined by EPA in its memorandum on deriving PRGs (EPA 2000) and by DTSC in its memorandum on use of PRGs for screening-level assessments at military facilities (DTSC 1994). In this approach, media concentrations of detected carcinogens are converted to cancer risk, and the COPC-specific risks are then summed to estimate the total risk associated with exposure to site COPCs. Because soil PRGs are derived based on exposure to COPCs through multiple pathways (in particular, soil ingestion, dermal contact with soil, and inhalation of airborne particles and VOCs released from soil), the risk calculated using this methodology represents the risk associated with exposure to all carcinogens for which PRGs are available for all three pathways. Similarly, for water, the cancer risks represent the risk from exposure to all carcinogens from ingestion of surface water and from inhalation of VOCs released during household use.

The cancer risk for a single chemical was estimated using the following equation:

$$CR_i = (EPC_i \times cPRG_i^{-1}) \times 10^{-6}$$

where:

CR_i = Excess lifetime cancer risk for chemical i (unitless)

EPC_i = Exposure point concentration for chemical i (mg/kg) for soil and microgram per liter [µg/L] for surface water)

$cPRG_i$ = Cancer-based preliminary remediation goal (mg/kg for soil and µg/L for surface water)

10^{-6} = Cancer risk value used to develop the PRG (unitless)

A "total" cancer risk estimate was then calculated for each sampling location by summing the CR_i values for all COPCs. In this assessment, these summations were made separately for soil (and sediment) and surface water. That is, the risk estimates for soil (and sediment) and surface water were not summed.

3.4.2 Estimation of the Hazard Quotient and Hazard Index

The HQ provides a quantitative characterization of the potential for noncancer effects associated with exposure to a single COPC. Similar to the process described for carcinogens in Section 3.4.1, an HQ was estimated by converting the detected concentrations of site COPCs to COPC-specific HQs using the following equation:

$$HQ_i = (EPC_i \times nPRG_i^{-1}) \times 1$$

where:

HQ_i	=	Site-related HQ for chemical i (unitless)
EPC_i	=	Exposure point concentration for chemical i (mg/kg for soil and µg/L for surface water)
$nPRG_i$	=	Noncancer preliminary remediation goal for chemical i (mg/kg for soil and µg/L for surface water)
1	=	Value of the HQ used to develop the PRG (unitless)

The HQs were then summed to derive an HI, the measure of the potential for noncarcinogenic health effects from exposure to multiple COPCs and through multiple exposure pathways. In this assessment, these summations were made separately for soil (and sediment), and surface water. That is, the risk estimates for soil (and sediment) and surface water were not summed.

A segregation of HI analysis was not performed for the Tier 1 PRG screen. In almost all cases, the HI was greater than 1 because the HQ for a single COPC (arsenic) was the major contributor to the HI. Thus, a segregation of HI analysis would not result in substantially better estimates of the HI.

3.4.3 Lead Evaluation

The evaluation of lead was conducted by comparing the concentration of lead in soil to the EPA Region 9 PRG of 400 mg/kg for a residential receptor and 750 mg/kg for a commercial/industrial worker receptor (EPA 2000). Areas at which the lead EPCs exceeded the industrial PRG were considered to represent a potential health risk under the identified land use. Conversely, areas where lead EPCs were below the PRG were not considered to represent a potential health risk. A tap water PRG is not available for lead, so an evaluation of lead was conducted only for soil.

3.5 TIER 1 RISK CHARACTERIZATION RESULTS

This section summarizes the results of the Tier 1 PRG screen conducted for RASSs 1, 2, 3, and 4. Cancer risk estimates and HIs were prepared for commercial/industrial worker and residential receptors addressing hypothetical future land use. However, industrial or residential development of RASS 1, which comprises marsh and wetland areas, would require placement of several feet of fill over the existing surface. Although portions of RASSs 2, 3, and 4 could be developed for residential or industrial use without significant modification of the existing topography, future development is considered highly unlikely, particularly in RASSs 2 and 3. Similar to RASS 1, development of marsh and wetland areas within RASSs 2, 3, and 4 would require placement of fill. As a result, the risk estimates for residential and industrial worker receptors are provided for reference, but should not be considered representative of the potential risks to the hypothetical receptors if land use were to change in the future.

The residential and industrial scenarios addressed the following exposure pathways for soil: incidental ingestion of soil, dermal contact with soil, inhalation of airborne soil particles as dust, and inhalation of VOCs released directly from soil. Ingestion of surface water and inhalation of VOCs released from surface water during domestic use were evaluated for the residential scenario. Potential exposure of a commercial/industrial worker receptor to surface water was not evaluated in the Tier 1 PRG screen.

The cancer risk estimates were compared to a "risk management range" to aid in the interpretation of the risk assessment results. EPA provides guidance on risk and exposure levels considered protective of human health. In the National Oil and Hazardous Substances Pollution Contingency Plan (Title 40 of the *Code of Federal Regulations* 300.430), EPA states that, "for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upperbound lifetime cancer risk to an individual of between 10^{-6} and 10^{-4}." The EPA directive, "Memorandum Regarding the Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions" (EPA 1991b), states that where cumulative cancer risks to an individual based on the reasonable maximum exposure (RME) for both current and future land use is less than 10^{-4} and no adverse noncancer effects exist, action generally is not warranted unless there are adverse environmental impacts. In comments to the Navy, EPA Region 9 and DTSC have recommended a risk management evaluation to protect human health when the risks are within the range of 1×10^{-6} to 1×10^{-4}. Consistent with these recommendations, the discussions in this risk assessment refer to the range 1×10^{-6} to 1×10^{-4} as the risk management range.

For noncarcinogens, an HI greater than 1 indicates there may be a concern for adverse noncancer health effects under the defined exposure conditions, and an HI of 1 or less indicates there is no appreciable risk of deleterious (noncancer) health effects (EPA 1989).

The results of the Tier 1 PRG screen for the resident and commercial/industrial worker receptors are presented separately on Figures 69, 70, and 71. The estimated cancer risks are shown for each sampling location, corresponding to risks less than, within, and greater than the risk management range, as follows:

- Cancer risks less than or equal to 1×10^{-6}
- Cancer risks between 1×10^{-6} and 1×10^{-4}
- Cancer risks greater than or equal to 1×10^{-4}

The HIs are shown on the same figures as the cancer risks, as follows:

- HIs greater than 1
- HIs less than or equal to 1

The purpose of the figures was to identify areas within the Litigation Area that (1) are considered a possible health concern under the assumed land use conditions (that is, cancer risks were greater than 1×10^{-4} and/or HIs were greater than 1), (2) are within the risk management range (that is, cancer risks were between 1×10^{-6} and 1×10^{-4} and HIs were less than or equal to 1) or (3) are considered to be of little or no health concern (that is, cancer risks were less than 1×10^{-6} and HIs were less than or equal to 1). The colors used on the figures were selected to highlight areas where cancer risks were greater than 1×10^{-4} and/or the HIs were greater than 1.

Tables 39 through 42 present summary statistics of the risk assessment results to supplement the information presented on the figures. For each RASS, the tables list the minimum and maximum risk; the 50th (median), 75th, and 95th percentile risks; and the number of locations at which the risk was less than, within, or greater than the risk management range. Tables presenting the cancer risk and HI estimates for each sampling location are included in Attachment F1 to this appendix.

Finally, the results of the lead analysis are presented on Figure 72. The maximum detected concentration of lead in soil or sediment at each sampling location is shown relative to the following benchmarks:

- Concentrations less than or equal to the EPA Region 9 residential PRG of 400 mg/kg (EPA 2000)
- Concentrations between 400 mg/kg and 750 mg/kg
- Concentrations greater than or equal to the EPA Region 9 industrial PRG of 750 mg/kg (EPA 2000)

The results of the Tier 1 PRG screen are discussed by RASS in the following sections.

3.5.1 Remedial Action Subsite 1

RASS 1 is divided into Spatial Units 1 through 11. Cancer risks for residential exposures to soil and sediment were greater than the upper end of the risk management range (1×10^{-4}), and the HIs were greater than 1 at most sampling locations within RASS 1, except Spatial Unit 8 (RASS 1 active remediated area surface soil) (Tables 39 and 40 and Figure 69). Arsenic was the single major contributor to the cancer risk and HI at all RASS 1 locations. At a few locations (eight or less depending on the metal), the HQs for cadmium, manganese, thallium, or zinc were greater than 1.

Under the industrial scenario (Tables 39 and 40 and Figure 70), cancer risks for exposure to soil and sediment were within or less than the risk management range (1×10^{-6} to 1×10^{-4}), and the HI was less than 1 at most locations within Spatial Units 1 through 5, 8, and 9. Cancer risks were greater than 1×10^{-4} and the HI was greater than 1, however, at many locations within Spatial Units 6 (central marsh surface soil) and 7 (central marsh ditch sediment) as well as at some locations along Spatial Units 10 (central reach of Lost Slough) and 11 (southwestern reach of Lost Slough). As for the resident, the primary contributor to the cancer risk and HI was arsenic.

A remedial action was previously conducted at Spatial Unit 8 to address risks to ecological receptors. The results of the Tier 1 screen indicate that this action effectively addressed potential risks to human health in the eastern portion of the unit. That is, the cancer risks were less than 1×10^{-6}, and HIs were less than 1 for both the resident and commercial/industrial worker receptors at sampling locations within the eastern half of Spatial Unit 8. Cancer risks were greater than 1×10^{-4} and/or HIs were greater than 1 at sampling locations along the western border of this unit. Spatial Unit 8 abuts Spatial Unit 6 to the west, an area of particularly high contamination. Due to sampling design and subsequent errors, some samples that were supposed to be collected along the western boundary of Spatial Unit 8 were actually collected outside of the active remediation area (that is, within Spatial Unit 6).

Cancer risks for residential exposures to surface water were greater than the upper end of the risk management range (1×10^{-4}), and the HIs were greater than 1 at almost all locations sampled within RASS 1 (Tables 41 and 42 and Figure 71). Arsenic was the primary contributor to the cancer risk and HI.

Lead concentrations in soil and sediment were less than the EPA Region 9 residential PRG of 400 mg/kg (EPA 2000) at all sampling locations within RASS 1 (Figure 72).

3.5.2 Remedial Action Subsite 2

RASS 2 comprises Spatial Unit 12, Southern Upland Surface Soil. A remedial action was conducted within the central portion of RASS 2 to address risks to ecological receptors. Within the northern and central portion of the remediated area, cancer risks for residential exposures to soil and sediment were less than 1×10^{-6}, and the HI was less than 1 (Tables 39 and 40 and Figure 69). Cancer risks were greater than 1×10^{-4} at two locations within the remediated area and at several locations within nonremediated areas. The HI was greater than 1 at three locations within the remediated area and at several locations within the nonremediated area. Arsenic was the major contributor to the cancer risk and HI at most locations. The only other significant contributor to the HI was cadmium.

For the industrial scenario, cancer risks for exposure to soil and sediment were within or less than the risk management range, and the HI was less than 1 at all locations within RASS 2 (Tables 39 and 40 and Figure 70).

Cancer risks for residential exposures to surface water were greater than the upper end of the risk management range (1×10^{-4}), and the HIs were greater than 1 at the six locations sampled within RASS 2 (Tables 41 and 42 and Figure 71). Arsenic was the major contributor to the cancer risk and HI.

Lead concentrations in soil and sediment were less than the EPA Region 9 residential PRG of 400 mg/kg (EPA 2000) at 11 of 18 locations within RASS 2 (Figure 72). Lead concentrations were greater than the industrial PRG of 750 mg/kg at two locations and between 400 and 750 mg/kg at five locations. The maximum detected concentration of lead within RASS 2 was 6,060 mg/kg.

3.5.3 Remedial Action Subsite 3

RASS 3 comprises Spatial Unit 13, Nichols Creek and Adjoining Pond Sediment. A remedial action was conducted along much of Nichols Creek and the RASS 3 pond area in the northern half of RASS 3 to address risks to ecological receptors. Cancer risks for residential exposures to soil and sediment associated with postremediation conditions were within the risk management range (1×10^{-6} and 1×10^{-4}) at most locations within the northern half of RASS 3 (Tables 39 and 40 and Figure 69). The HI was greater than 1 at several locations, however, particularly in the area surrounding the pond. Arsenic was the major contributor to the cancer risk and HI at most locations. Other COPCs for which the HQ was greater than 1 were cadmium (at location R03WD155), zinc (R03WD155), and Aroclor-1242 (R03SS214). Cancer risks were generally less than 1×10^{-6}, and the HIs were less than 1 at locations within the southern half of RASS 3.

For the industrial scenario, cancer risks for exposure to soil and sediment were within or less than the risk management range, and the HI was less than 1 at all locations within RASS 3 (Tables 39 and 40 and Figure 70).

Cancer risks for residential exposure to surface water were greater than the upper end of the risk management range (1×10^{-4}), and the HIs were greater than 1 at almost all locations sampled within RASS 3 (Tables 41 and 42 and Figure 71). Arsenic was the major contributor to the cancer risk and HI.

Lead concentrations in soil and sediment were less than the EPA Region 9 residential PRG of 400 mg/kg (EPA 2000) at almost all sampling locations within RASS 3 (Figure 72). Lead concentrations were greater than the industrial PRG of 750 mg/kg at four locations, with a maximum detected concentration of 5,980 mg/kg.

3.5.4 Remedial Action Subsite 4

RASS 4 comprises Spatial Units 14 (upland surface soil) and 15 (RASS 4 wetland sediment). Remedial actions were conducted in two discrete areas of RASS 4 to address risks to ecological receptors. Cancer risks for residential exposures to soil and sediment associated with postremediation conditions were greater than the upper end of the risk management range (1×10^{-6}) at most locations except along the eastern side of RASS 4 where cancer risks were less than or within the risk management range, and the HIs were less than 1 (Tables 39 and 40 and Figure 69). Arsenic was the major contributor to the cancer risk and HI. The only other significant contributors to the HI were mercury and zinc.

For the industrial scenario, cancer risks for exposure to soil and sediment were within or less than the risk management range and the HI was less than 1 at all locations within RASS 4 (Tables 39 and 40 and Figure 70).

Cancer risks for residential exposures to surface water were greater than the upper end of the risk management range (1×10^{-4}), and the HI was greater than 1 at most locations sampled within RASS 4 (Tables 41 and 42 and Figure 71). Arsenic was the major contributor to the cancer risk and HI.

Lead concentrations in soil and sediment were less than the EPA Region 9 residential PRG of 400 mg/kg (EPA 2000) at 14 of 18 locations evaluated within RASS 4 (Figure 72). Lead concentrations were greater than the industrial PRG of 750 mg/kg at two locations, with a maximum detected concentration of 2,990 mg/kg.

3.6 UNCERTAINTIES

Uncertainty is inherent in many aspects of the risk assessment process. These uncertainties include (1) general uncertainties associated with the assumptions, models, and extrapolations that make up the risk assessment process and (2) site-specific uncertainties associated with the available sampling data and site-specific approaches used in the risk assessment. The following discussion focuses on uncertainties specific to the Tier 1 screen conducted for the Litigation Area sites.

3.6.1 Sampling and Analytical Program

Sample data collected from a site must be used to evaluate conditions of a site as a whole. The HHRA was based on the analytical data collected during the 5 years of postremediation monitoring (PRC 1996, 1997a; TtEMI 1998, 1999a, 2000a) and the QEA (PRC 1997b). The total number of samples collected was more than adequate for characterization of contaminant levels and the sampling design provided broad spatial coverage of soil, sediment, and surface water across each RASS. One factor considered in the review of data quality was that not all samples were analyzed for the full suite of analytes. Specifically, samples collected as part of the postremediation monitoring were analyzed only for six metals of concern identified in the RI: arsenic, cadmium, copper, lead, selenium, and zinc. Samples collected in RASS 4 were also analyzed for mercury. These metals were selected based on the analytical results from earlier studies that indicated that they were the primary metals of concern. The QEA expanded the analytical program to include all Contract Laboratory Program (CLP) metals, SVOCs, and pesticides/PCBs. VOCs, which were not expected based on the history of the Litigation Area, were analyzed for in a limited number of samples. The sampling strategy was carefully designed to ensure broad spatial coverage and target areas of expected contamination. Thus, although analytical results for the full suite of CLP analytes were not available for each sampling location, the totality of the available data provided adequate site characterization. For these reasons, confidence in the available analytical data was considered high.

Soil and sediment samples were collected within the 0 to 18 inch depth interval to support the ecological risk assessment; deeper samples were not collected. As a result, potential impacts to human receptors under a future site configuration (0 to 10 feet bgs) could not be quantified. However, because contamination at the Litigation Area was due primarily to surface releases from neighboring chemical companies, the highest contaminant concentrations are expected to be associated with surface soils and sediments (that is, within the top 2 feet). Additional information on contaminant concentrations in subsurface soils would be needed only if land use were to change in the future such that subsurface soils could be brought to the surface through activities such as excavation or regrading.

During the site inspection tour on July 27, 2002, the Navy and the regulatory agencies observed an area of semilithified soil near the RASS 4 remediated area (Section 6.1.1 of the five-year review report). The unusual nature of the soil raised questions about its source and chemical composition. The Navy will collect and analyze a few biased samples of this soil (Section 10.0 of the five-year review report) and compare the chemical concentrations with existing RASS 4 data to evaluate whether (1) new COPCs are present or (2) chemical concentrations are higher in this material than in surrounding areas. Because analytical results for this material are currently not available, some uncertainty is introduced into the risk estimates for RASS 4.

3.6.2 Detection Limits

The relatively high DLs for some organic compounds are the main source of uncertainty in the interpretation of site concentrations of some organic compounds. The potential impacts of the DLs on the Tier 1 results were assessed by comparing sample DLs to the residential PRGs for soil. The purpose of this comparison was to identify analytes with DLs greater than their health-based PRG; such analytes could be present at concentrations that represent a health risk, even though they were reported as not detected. This comparison is shown in Table 43, which lists all analytes reported as not detected that had a DL greater than the residential PRG in one or more samples. For each analyte, the table shows the total number of samples analyzed; the PRG; the number of samples with DLs greater than the PRG, 2 times the PRG, and 10 times the PRG; and the range of DLs. The information presented in this table is discussed below for each compound.

- 2-Nitroaniline. Although the DLs for 2-nitroaniline were greater than the PRG in 47 of 162 samples, the DLs did not exceed 2 times the PRG in any sample. If present at the reported DLs, the HIs for a resident receptor would range from 1.1 to 2.0.

- Arsenic. Arsenic was detected in almost all samples analyzed. The few samples reported as not detected in which DLs were greater than residential PRG do not affect the interpretation of the Tier 1 results.

- Bis(2-chloroethyl)ether. The DLs for bis(2-chloroethyl)ether were greater than the PRG in 152 of 162 samples, and 10 times the PRG in 14 samples. If present at the reported DLs, the cancer risks for a resident receptor would range from 1×10^{-6} to 1.3×10^{-5}.

- Polynuclear aromatic hydrocarbons (PAH). As a class, the DLs for PAHs were greater than their PRGs in most samples analyzed. In particular, the DLs for benzo(a)pyrene were greater than the PRG in 151 of 161 samples, and the DLs for dibenz(ah)anthracene were greater than the PRG in 157 samples. For these two compounds, DLs were greater than 10 times the PRG in over 100 samples. If present at the reported DLs, the cancer risks for benzo(a)pyrene and dibenz(ah)anthracene would range from 1×10^{-6} to 4.5×10^{-5}. The cancer risks for the remaining PAHs listed in Table 43 would range from 1×10^{-6} to 4.5×10^{-6}.

- PCBs (Aroclor-1221, -1232, -1242, -1248, -1254, and -1260). Although the DLs for PCBs were greater than the PRG in up to 69 of 168 samples analyzed for PCBs, the DLs exceeded 2 times the PRG in only 8 samples. If present at the reported DLs, the cancer risks would range from 1×10^{-6} to 2.5×10^{-6}.

- Pentachlorophenol. Although the DLs for pentachlorophenol were greater than the PRG in 61 of 162 samples, the DLs exceeded 2 times the PRG in only 4 samples. If present at the reported DLs, the cancer risks would range from 1×10^{-6} to 2.3×10^{-6}.

- Thallium. The DL for thallium was greater than the residential PRG in only 1 of 99 samples. All other samples had detected concentrations of thallium, or for samples reported as not detected, DLs less than the PRG.

- Toxaphene. The DLs for toxaphene were greater than the PRG in 96 of 168 samples, and 2 times the PRG in 30 samples. The DLs were less than 10 times the PRG in all samples. If present at the reported DLs, the cancer risks would range from 1×10^{-6} to 3.2×10^{-6}.

The above review indicates that under worst-case assumptions, the potential cancer risks for analytes with elevated DLs are within the risk management range (1×10^{-6} to 1×10^{-4}); no DL was associated with a risk greater than 1×10^{-4}, and the maximum HI was no greater than 2.

Because of the point-by-point approach used in the Tier 1 screen, analytes reported as not detected at a sampling location were not evaluated for that location. In conventional risk assessments in which EPCs are based on upper confidence limits of the average concentration within a defined exposure unit, nondetect data are typically accounted for by using one-half the DL as a proxy concentration. (This substitution is made only for compounds detected in at least one sample within the exposure unit. That is, an analyte reported as not detected in all samples analyzed, would not be evaluated in the assessment.) Not including a proxy concentration for the nondetect data in the Tier 1 screen may have resulted in an underestimate of the potential cancer risks and HIs.

For the Litigation Area sites, the potential impacts of the elevated DLs and the approach used to address the nondetect data must be considered in the context of the cancer risks and HIs estimated for the detected analytes. That is, arsenic was the major risk driver, with estimated cancer risks (for a resident receptor) greater than 1×10^{-4} and HIs greater than 1 at many locations within all four RASSs. Given the very high risks associated with detected analytes, the impact of the elevated DLs for some compounds and the assumption that the EPC for nondetect data was zero would not significantly impact the overall results or conclusions of the Tier 1 screen.

3.6.3 Selection of Chemicals of Potential Concern

The primary uncertainty in the selection of COPCs for evaluation in a risk assessment is that an analyte is incorrectly included or excluded from evaluation in a risk assessment. In general, the selection process under the Tier 1 screen was conservative so that the more likely error was that analytes were inappropriately included as COPCs at some sampling locations. This conclusion is based on the following considerations.

- Ambient screen for surface water. In the absence of an ambient data set for metals in surface water, all detected analytes were identified as COPCs.

- Ambient screen for soil and sediment. COPCs were selected separately for each sampling location. Under this approach, a metal was selected as a COPC by comparing the detected concentration of each metal to its ambient limit (the 95th percentile of the ambient data set). More rigorous statistical methods (hypothesis testing) could not be used because only a single datum was available for each metal at each location. By chance alone, some concentrations that are representative of ambient conditions will exceed the ambient level, resulting in the incorrect identification of a metal as a COPC for that location.

- Organic compounds. Ambient limits have not been established for organic compounds in soils, sediments, or surface water at the Litigation Area sites. Although most organic compounds are present as a result of a site-related release, an important exception is the PAHs, which are found in the environment as a result of anthropogenic sources (for example, from vehicle emissions and other combustion sources) and natural sources (for example, volcanoes and fires). Petroleum hydrocarbons represent a possible site-related source of PAHs. Ambient limits were not established for PAHs at the Litigation Area and all detected PAHs were retained as COPCs. The detected concentrations of PAHs at many locations were consistent with ambient concentrations reported in urban soils in the United States (Agency for Toxic Substances and Disease Registry 1995). Although TPH is a possible source at the Litigation Area, it is likely that PAHs detected at some locations were not site related. Although retaining all PAHs as COPCs was conservative, it was also recognized that the evaluation of PAHs was confounded by the relatively high DLs for these compounds, as discussed in Section 3.6.2.

One additional uncertainty associated with the COPC selection process was the comparison of the sediment concentrations with the ambient data set for soil. This comparison could lead to either inappropriate inclusion or exclusion of a metal as a COPC in sediment samples.

It is expected that the conservative process used to select COPCs resulted in the retention of some detected analytes as COPCs that were not related to site activities, resulting in the possible overestimation of risks. However, given the very high cancer risks and HIs associated with arsenic present at the Litigation Area sites, this potential overestimation would not be expected to substantially impact the results and conclusions of the Tier 1 screen.

3.6.4 Exposure Point Concentrations, Exposure Pathways, and Receptors

All potentially complete and significant exposure pathways were evaluated in the Tier 1 screen. That is, the PRGs used to assess risks accounted for incidental ingestion of soil, dermal contact with soil, and inhalation of particles and/or vapors in ambient air, which were identified as the primary exposure pathways for a potential future resident or commercial/industrial worker receptors. One pathway not accounted for in the PRG framework was exposure from inhalation of vapors released from soil to indoor air. However, no building structures are present at the Litigation Area and development is not planned for the future. Further, VOCs were not expected contaminants based on consideration of possible sources and the transport processes by which the Litigation Area sites were contaminated (discussed in Section 3.2 of the five-year review report). For these reasons, exclusion of this pathway was not expected to significantly impact the results of the Tier 1 screen.

The highest concentrations of metals at the Litigation Area were generally detected in the RASS 1 marsh area. However, EPCs used in the risk assessment, which were the maximum detected concentrations at each sampling location, may overestimate the concentrations of COPCs on the marsh surface. A sediment accretion study conducted in 1999 showed that the marsh is accreting sediments at a rate of approximately 2.5 millimeters per year. A related study conducted in 2000 examined the vertical distribution of metals contamination in the marsh surface. X-ray fluorescence profiling showed that the highest concentrations of metals were generally 3 to 5 inches below the marsh surface, with substantially lower concentrations above the contaminated soil horizon. These findings suggest that the contaminated sediment horizon has been progressively buried by cleaner sediments brought into the marsh from Suisun Bay and that the HHRA may overestimate the risks associated with exposure to surface soils and sediments at the marsh under current site conditions. The accretion and metals profiling studies are described in detail in Appendix E of this five-year review report.

As previously discussed, a change in current land use is considered very unlikely, particularly in RASSs 1, 2, and 3. Industrial or residential development of RASS 1, which comprises marsh and wetland areas, would require placement of several feet of fill materials over the existing surface. Although portions of RASSs 2, 3, and 4 could be developed for residential or industrial use without significant modification of the existing topography, future development is considered highly unlikely, particularly in RASSs 2 and 3. Finally, similar to RASS 1, development of the marsh and wetland areas within RASSs 2, 3, and 4 would require placement of fill materials. As a result, risk estimates for the residential and industrial worker receptors provide benchmarks for comparison purposes, but they should not be considered representative of the potential risks to these hypothetical receptors if land use where to change in the future.

3.6.5 Iron Evaluation

Iron was eliminated as a COPC on the basis of an essential nutrient screen and was therefore not quantitatively evaluated in the Tier 1 screen. Although eliminated from the quantitative evaluation, EPA and DTSC requested that a qualitative assessment of health impacts from exposure to iron be presented.

Although iron is an essential nutrient, EPA Region 9 has developed soil PRGs of 23,000 mg/kg for residential land use and 100,000 mg/kg for commercial/industrial land use (EPA 2000). The concentrations of iron in soil at the Litigation Area sites are summarized in the following table.

Summary Statistics for Iron Concentrations in Soil at the Litigation Area Sites

Site	Detection Frequency	Range (mg/kg)	Ambient Limit (mg/kg)	Number of Locations Exceeding PRG	Number of Locations Exceeding Ambient Limit and PRG
RASS 1	64/64	8,320 to 60,500	58,000	56	1
RASS 2	1/1	21,400	58,000	0	0
RASS 3	17/17	12,100 to 76,600	NA	9	9
RASS 4	7/7	11,900 to 28,800	NA	3	3

Notes:

mg/kg Milligram per kilogram
NA Not available
PRG Preliminary remediation goal
RASS Remedial action subsite

The iron PRG is based on a provisional RfD (0.3 mg/kg-day) developed by the National Center for Environmental Assessment (NCEA). The PRG was not used to estimate HQs in the HHRA because the provisional RfD (on which the iron PRG is based) was developed using different methods and toxicological endpoints than verified RfDs. The evaluation of iron concentrations at the Litigation Area therefore considered the following:

- The concentrations of iron at the Litigation Area sites are within the range of concentrations present throughout the conterminous United States (7,000 to 550,000 mg/kg) (Lindsay 1979) and the western United States (100 to greater than 100,000 mg/kg) (Shacklette and Boerngen 1984).
- Bradford and others (1996) report iron concentrations of 10,000 to 87,000 mg/kg in benchmark California soils selected as “most representative” of California soils. Concentrations of iron in all Litigation Area samples are less than the upper end of this range.
- Adverse health effects associated with background concentrations of iron in soils in California have not been reported.

- The provisional RfD of 0.3 mg/kg-day is the average intake for all Americans, measured in the second National Health and Nutritional Examination Survey. The NCEA notes that the provisional RfD is within the range of the recommended daily allowances (RDA) (National Research Council [NRC] 1989) and is higher and lower in some cases. For example, the RDA of 0.13 mg-iron/kg-day for young adult men is higher than the RfD and the RDA of 1.11 mg iron/kg-day for children ages 6 months to 1 year is lower than the RfD. The NCEA also notes that the provisional RfD may not be protective for people with inherited disorders in iron metabolism. Additionally, NCEA's use of an average intake rate indicates that a large fraction of the U.S. population has a higher intake rate than the provisional RfD of 0.3 mg-iron/kg-day; NCEA does not discuss the risks borne by that fraction of the population (EPA 1999).

- The RDA for iron is 15 mg/day for adult females and 10 mg/day for males. The RDA does not represent a maximum safe dose; rather, it is a minimum requirement for proper nutrition that is routinely supplied in vitamin supplements (NRC 1989).

- The exposure assessment uses a conservative assumption of 100 mg/day as the soil ingestion rate for the adult resident receptor. Based on RDAs of 15 and 10 mg-iron/day and the soil ingestion rate of 100 mg/day, RDAs would be provided at concentrations of 150,000 milligrams of iron per kilogram of soil (mg-iron/kg-soil) for adult female receptors and 100,000 mg-iron/kg-soil for adult male receptors.

- The PRGs use a conservative assumption of 200 mg/day as the soil ingestion rate for the child resident receptor. Based on the RDA of 10 mg/day and the ingestion rate of 200 mg/day, a concentration of 50,000 mg-iron/kg-soil would provide the RDA of iron for children.

Based on these considerations, iron was not considered a threat to human health at the Litigation Area sites.

4.0 TIER 2 RISK-BASED CONCENTRATION SCREEN

The results of the Tier 1 assessment indicate that cancer risks were greater than the risk management range and HIs were greater than 1 for both resident and commercial/industrial worker receptors in areas within all four RASSs. The risks estimated for these receptors, however, overestimate potential risks to individuals at the Litigation Area under existing and expected future site conditions. Currently, there are no full-time workers within the Litigation Area, and residences are not present or anticipated in the future. A Tier 2 RBC screen was therefore conducted to provide more representative estimates of potential risks to individuals currently working within the Litigation Area on an intermittent basis.

RBCs are conceptually similar to the EPA Region 9 PRGs (EPA 2000). That is, RBCs are soil or surface water concentrations corresponding to a cancer risk of 1×10^{-6} or an HI of 1; however, RBCs are developed using exposure parameter values that describe a site-specific receptor in place of the default exposure values used to develop PRGs. Similar to the Tier 1 screen, Tier 2 cancer risks and HIs were

estimated on the basis of the ratio of the maximum detected concentration at each soil and surface water sampling location to the receptor-specific RBC.

4.1 DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

The HHRA data set used for the Tier 1 PRG screen was also used for the Tier 2 RBC screen; however, a different COPC selection process was used for the Tier 2 screen, as described in the following sections.

4.1.1 Soil and Sediment

Soil and sediment COPCs were selected for each sampling location by comparing the maximum detected concentration of each analyte at that location with its residential PRG (Table 37). Only analytes with maximum detected concentrations exceeding the PRG were retained as COPCs. Metals were further screened and retained if the maximum detected concentration at the sampling location exceeded the ambient limit. This screen was conducted to focus the Tier 2 RBC screen on those chemicals with the potential to contribute significantly to the total risk estimates. The chemical-specific RBCs used in the Tier 2 screen were approximately 10 to 100 times higher than the residential PRGs. Thus, cumulative risk from analytes screened on the basis of a comparison with residential PRGs would not contribute significantly to the risk for the site-specific receptor, which is based on the RBCs. One consequence of the approach used to select COPCs was that some locations analyzed in the Tier 1 screen were not analyzed in the Tier 2 screen. That is, locations where concentrations of all detected analytes were less that the ambient limit or the PRG were eliminated from the assessment. Uncertainties associated with the approach for selecting COPCs for the Tier 2 screen are discussed in Section 4.5.

The soil and sediment COPCs identified at one or more sampling locations using the previously described screen are listed in Table 44.

4.1.2 Surface Water

Surface water COPCs were selected for each sampling location by comparing the maximum detected concentration of each analyte to the tap water PRG (Table 38). Only analytes with maximum detected concentrations exceeding the PRG were retained as COPCs at that location. The surface water COPCs identified at one or more sampling locations are listed in Table 45.

4.2 EXPOSURE ASSESSMENT

This section focuses on the elements of an exposure assessment specific to the Tier 2 RBC screen. These elements are (1) identification of a site-specific receptor to represent upperbound exposures for current and expected future use of the Litigation Area, (2) identification of complete exposure pathways, and (3) estimation of EPCs.

4.2.1 Tier 2 Receptor

The Tier 2 RBC screen evaluated a mosquito abatement worker, identified as the RME receptor under current and expected future land use conditions. Potential exposures of the mosquito abatement worker are expected to be higher than those of other potential receptors at the Litigation Area and thus represent an upperbound estimate of risks to other receptors. The mosquito abatement worker receptor was identified for evaluation based on information provided by NWSSBD Concord (TtEMI 2001b) and the Contra Costa County Mosquito and Vector Abatement District (CCCMVAD) (TtEMI 2001a), described in the following text. The regulatory agencies concurred with the selection of this receptor at a meeting on May 2, 2000.

The potential current and future receptors initially considered for evaluation in the Tier 2 RBC screen were Navy personnel, trespassers, and mosquito abatement workers. Of these receptors, the Navy stated that the only individuals routinely entering the Litigation Area are workers of the CCCMVAD (TtEMI 2001b). Navy personnel conduct routine surveillance from locations outside the Litigation Area sites. Therefore, security personnel access the area only when responding to an emergency. The only other personnel entering the Litigation Area are Navy contractors responsible for environmental programs. However, entry by these individuals is irregular, infrequent, and of short duration. Exposures of the mosquito abatement worker would be higher than exposures experienced by Navy personnel entering the area only intermittently, as discussed further in this section.

The Navy controls access to and patrols the Litigation Area to restrict access of unauthorized persons to the area. However, during the site inspection tour in July 2001, the Navy and the regulatory agencies observed evidence of trespass at RASS 4 (see Section 6.1 of the five-year review report). Observations included motorcycle tracks in the middle of RASS 4, an unlocked gate along Port Chicago Highway, and a second gate that had been broken open. The Navy facility coordinator alerted base security, and Navy personnel replaced the locks and secured the gates that afternoon. However, the observed security lapse initiated a broader review of access controls at RASS 4. The Navy will take specific measures to remedy access controls, as described in Section 10.3 of the five-year review report. Because of the planned

additional measures to control access, a trespasser scenario was not specifically evaluated in the Tier 2 RBC screen. However, the risks estimated for the mosquito abatement worker provide a rough estimate of the potential risks to trespassers. The Tier 2 RBC screen for the mosquito abatement worker is based on the assumption of intermittent access and evaluates potential exposures to soils, which are similar to potential exposures to trespassers.

CCCMVAD mosquito abatement workers were identified as the RME receptor for evaluation in the Tier 2 RBC screen because exposure of these workers is expected to be higher than exposures of the other potential receptors identified at the Litigation Area. CCCMVAD workers inspect and sample ponded water for mosquito breeding in areas between ditches and spray breeding areas after ascertaining the necessity for treatment. These activities are conducted approximately 30 days per year; inspection takes about 2 hours, and spraying generally requires up to 4 hours. The same workers usually perform these activities (TtEMI 2001a). Most of these activities occur in RASSs 1 and 2, where the mosquito abatement ditches are located; however, workers pass through RASS 3 to gain access to RASSs 1 and 2. Although not present at RASS 4, the risks estimated for the mosquito abatement worker provide a surrogate for other receptors (such as trespassers) present intermittently at RASS 4.

4.2.2 Exposure Pathways

Mosquito abatement workers may come in contact with soil, sediment, and surface water during inspection and spraying activities at the Litigation Area. The soil RBCs were based on the following exposure pathways:

- Incidental ingestion of soil and sediment
- Dermal contact with soil and sediment
- Inhalation of dust particles suspended in air

The surface water RBCs were based on incidental dermal contact with water.

4.3 TIER 2 RISK-BASED CONCENTRATIONS

The soil and sediment RBCs for the Tier 2 screen were developed using the EPA Region 9 equations for a commercial/industrial worker receptor (EPA 2000) and exposure parameters that describe the mosquito abatement worker receptor. The EPA Region 9 tap water PRGs (EPA 2000) do not include an evaluation of the dermal contact with water pathway, the only complete exposure pathway identified for surface water for the mosquito abatement worker. Accordingly, the surface water RBCs were derived using

equations presented in EPA guidance for estimating dermal intake (EPA 1998) and in EPA guidance for developing PRGs (EPA 1991c). The derivation of the equations and calculation of the surface water RBCs is documented in Attachment F2.

The exposure parameter values used to derive the soil and surface water RBCs for the mosquito abatement workers are listed in Table 36. For several parameters, the EPA Region 9 default values for a commercial/industrial worker were used. The type of clothing worn by the workers (long-sleeved shirts, long pants, steel-toed hip waders, goggles, gloves, and generally dust/mist masks [TtEMI 2001a]) was considered in developing receptor-specific parameters. The rationale for the receptor-specific values is discussed in the following list:

- General exposure parameters. A receptor-specific exposure frequency of 30 days per year was used based on information provided by CCCVMAD (TtEMI 2001a).

- Inhalation pathway. A receptor-specific inhalation rate of 15 cubic meters per day (m^3/day) was used, based on the default inhalation rate of 20 m^3/day per 8-hour workday (EPA 1991a) and the exposure time of 6 hours per day (2 hours for inspection and 4 hours for spraying) provided by CCCVMAD (TtEMI 2001a).

- Soil ingestion pathway. A receptor-specific value of 100 mg/day was used for the soil ingestion rate. Incidental ingestion of soil occurs by transfer of soil from hands or other body parts to the mouth, through removal of suspended dusts adhering to the mouth area, and through inhalation of dust particles that are subsequently swallowed. The CCCVMAD (TtEMI 2001a) indicated that workers wear gloves and dust/mist masks, which would substantially reduce potential exposure from ingestion of soil. The soil ingestion rate of 100 mg/day is higher than the recommended default for a commercial/industrial worker of 50 mg/day (EPA 1991a), the same as the recommended value for agricultural workers (EPA 1997), and lower than the default value of 480 mg/day (EPA 1991a) for a construction worker who is not wearing any type of protective clothing or equipment.

- Dermal contact with surface water. The exposed skin surface area in contact with surface water was assumed to be 2,100 square centimeters, representing the hands and forearms (EPA 1997). Because workers wear waders, it is unlikely that the feet or legs would contact surface water. Although workers also wear gloves, the assumed surface area allows for the possibility that workers either remove their gloves or that water enters the gloves. Exposure to surface water was assumed to occur for 1 hour per visit.

Table 44 presents the soil and sediment RBCs and Table 45 presents the surface water RBCs. The RBCs were derived using the receptor-specific exposure parameters presented in Table 36 for the mosquito abatement worker.

4.4 TIER 2 RISK CHARACTERIZATION RESULTS

The risk characterization step for the Tier 2 RBC screen used the same calculation methods as the Tier 1 PRG screen, as described in Sections 3.4.1 and 3.4.2. Cancer risk estimates and HIs were prepared for the mosquito abatement worker receptor, the site-specific receptor identified for evaluation under both current and expected future land use conditions. The following exposure pathways were evaluated for soil: incidental ingestion of soil, dermal contact with soil, inhalation of airborne soil particles as dust, and inhalation of VOCs released directly from soil. For surface water, dermal contact was evaluated. A Tier 2 evaluation was not conducted for lead because the results of the Tier 1 screen indicated that a more detailed analysis was not warranted.

The results of the Tier 2 RBC screen are discussed by RASS in the following sections.

4.4.1 Remedial Action Subsite 1

The estimated cancer risks for the mosquito abatement worker receptor from exposures to soil and sediment were less than or within the risk management range (1×10^{-6} to 1×10^{-4}), and the HIs were less than 1 at nearly all locations within RASS 1. The exceptions were Spatial Units 6, 7, and 8 (Figure 73). Cancer risks were greater that 1×10^{-4} and/or the HIs were greater than 1 at some locations within Spatial Units 6 (central marsh surface soil) and 7 (central marsh ditch sediment), and along the western boundary of Unit 8 (RASS 1 active remediation area surface soil). As in the Tier 1 screen, arsenic was the major contributor to the cancer risks and HIs. Arsenic concentrations at these locations ranged from about 900 to 3,260 mg/kg. The Tier 2 cancer RBC for arsenic is 8.9 mg/kg and the noncancer RBC is 1,426 mg/kg.

The Tier 2 screen evaluates risks at each sampling location; however, the mosquito abatement worker receptor would not spend the entire 6 hours at a single location or return to the same location during each of 30 visits over the course of a year. That is, the worker would be exposed for only a short period of time at any one location while conducting inspection and spraying activities. Potential cancer risks to the mosquito abatement worker are better interpreted using percentiles to describe the distribution of risks. As shown in Table 39, the 50th, 75th, and 95th percentile cancer risks were 1×10^{-5}, 3×10^{-5}, and 1×10^{-4}. The corresponding percentiles for the HIs were 0.07, 0.2, and 0.8 (Table 40).

The estimated cancer risks from incidental exposure of a mosquito abatement worker receptor to surface water were less than the lower end of the risk management range (1×10^{-6}), and the HI was less than 1 at all locations evaluated (Figure 74).

4.4.2 Remedial Action Subsite 2

The estimated cancer risks for the mosquito abatement worker receptor from exposures to soil and sediment were less than or within the risk management range, and the HIs were less than 1 at all locations within RASS 2 (Figure 73). Cancer risks from incidental exposure to surface water were less than the lower end of the risk management range (1×10^{-6}), and the HIs were less than 1 (Figure 74).

4.4.3 Remedial Action Subsite 3

The estimated cancer risks for the mosquito abatement worker receptor from exposures to soil and sediment were less than or within the risk management range, and the HIs were less than 1 at all locations within RASS 3 (Figure 73). Cancer risks from incidental exposure to surface water were less than the lower end of the risk management range (1×10^{-6}), and the HI was less than 1 (Figure 74).

4.4.4 Remedial Action Subsite 4

The estimated cancer risks for the mosquito abatement worker receptor from exposures to soil and sediment were less than or within the risk management range, and the HIs were less than 1 at all locations within RASS 4 (Figure 73). Cancer risks from incidental exposure to surface water were less than the lower end of the risk management range (1×10^{-6}), and the HIs were less than 1 (Figure 74).

4.5 UNCERTAINTIES

The factors contributing to uncertainties in the Tier 1 assessment, discussed in Section 3.6, are also applicable to the Tier 2 screen. This section discusses additional uncertainties associated with the Tier 2 screen.

The approach for selecting soil and sediment COPCs for the Tier 2 screen contains biases that result in the potential to both under- and overestimate risks. As discussed in Section 4.1, only analytes with maximum detected concentrations exceeding the higher of their PRG and ambient limit were retained as COPCs. The selection process was applied at each sampling location. One consequence of this approach was that some locations analyzed in the Tier 1 screen were not analyzed in the Tier 2 screen. That is, locations where concentrations of all detected analytes were less than the ambient limit and the PRG were eliminated from the assessment. These locations were not shown on the figures, resulting in a bias toward locations with the highest risks. This bias also affects estimates of the average and the percentile risks for a RASS. That is, the average and the percentiles were higher than would be estimated if the PRG screen

had not been used to select COPCs because locations at the lower end of the risk distribution were eliminated from the analysis.

At the same time, using a PRG screen to select COPCs underestimates potential risks. As discussed above, locations where all analytes were screened were removed from the analysis. However, risks at these locations would generally be less than 10^{-6}, and HIs would be less than 1. In addition, cancer risks and HIs at locations included in the analysis may be underestimated. This is because only a subset of detected analytes was evaluated at each location. However, analytes evaluated were the major risk drivers, and risks for the deleted analytes were 10- to 100-fold less than those included in the assessment, so the magnitude of underestimation would be small.

The assumptions used to estimate the exposure of the mosquito abatement worker receptor were based on information provided by the CCCMVAD (TtEMI 2001a). The specific information provided good estimates of the exposure time and exposure frequency of workers. However, considerable uncertainty was associated with other exposure parameters needed to assess the soil ingestion pathway and dermal contact with soil and surface water pathways. In particular, little information was available to estimate soil ingestion rates associated with the specific activities of the mosquito abatement worker receptor, the skin surface area in contact with soil or surface water, or the amount of soil and sediment adhering to the skin. The soil ingestion pathway was the major contributor to the estimated risks, so that the risk results were most sensitive to the assumed soil ingestion rate. The dermal pathway was a less important contributor to the risks, so that the assessment results are less sensitive to the assumed values for skin surface area and the amount of soil and sediment adhering to the skin. The uncertainties in the selected values for these parameters could overestimate or underestimate the risks for these pathways.

The primary uncertainty contributing to interpretation of the Tier 2 results was the point-by-point approach used to assess cancer risks and HIs. Underlying the point-by-point assessment was the assumption that the receptor (the mosquito abatement worker) was exposed at each sampling location 6 hours per day, 30 days per year, over the entire 25 years that exposure was assumed to occur. However, the inspection and spraying activities conducted by the CCCVMAD are such that a worker would be exposed for only a short period of time at any one location. The potential risks associated with repeated, long-term exposures at the Litigation Area are thus better interpreted using percentiles to describe the distribution of risks (presented in Tables 39 through 42), as previously discussed in Section 4.4.

5.0 SUMMARY

The objective of the HHRA was to assess potential risks associated with exposure to contaminants detected in surface soil, sediment, and surface water in RASSs 1 through 4 in the Litigation Area. A two-tiered approach was used: the Tier 1 PRG screen evaluated potential risks to commercial/industrial worker and resident receptors under the assumption that land use may change in the future, and the Tier 2 RBC screen evaluated a site-specific receptor (a mosquito abatement worker), present intermittently at the Litigation Area under current and expected future site conditions. Cancer risks and HIs were estimated separately for each sampling location, and the results were plotted on Figures 69 through 71, 73, and 74. The evaluation of lead was conducted by comparing the concentration of lead in soil with the EPA Region 9 PRGs of 400 mg/kg for a residential receptor and 750 mg/kg for a commercial/industrial worker receptor. Soil lead concentrations are shown on Figure 72.

Tier 1 PRG Screen

NWSSBD Concord is an active naval base and is not scheduled to close; future land use at the Litigation Area sites is not expected to change from current use; and future development in the marsh and wetland areas within RASSs 1, 2, 3, and 4 would require placement of fill materials over the existing surface. As a result, risk estimates for the residential and industrial worker receptors provide benchmarks for comparison purposes that can be used to support decisions on the need for restrictions if land use were to change in the future; however, the risk estimates should not taken to represent the absolute risks to these hypothetical receptors.

For the resident receptor, the results of the Tier 1 screen indicated that cancer risks from exposure to surface soil and sediment were greater than the upper end of the risk management range (1×10^{-4}), and the HIs were greater than 1 over extensive areas of RASSs 1, 2, 3, and 4. Arsenic was the single major contributor to the cancer risk and HI at almost all locations, and incidental ingestion of soil was the major exposure pathway. Cancer risks for residential exposures to surface water were greater than the upper end of the risk management range (1×10^{-4}), and HIs were greater than 1 at almost all locations sampled. Again, arsenic was the primary contributor to the cancer risk and HI for surface water. Surface water in the sloughs, ditches, and impoundments at the Litigation Area is not potable, so the Tier 1 screen for surface water yields extremely conservative estimates of potential risk. Concentrations of lead in soil and sediment were less than the EPA Region 9 PRG of 400 mg/kg (EPA 2000) at most locations within RASSs 1 through 4; concentrations were greater than the PRG at a limited number of locations. The maximum concentration of lead was detected in RASS 2 at a concentration of 6,060 mg/kg,

For the commercial/industrial worker receptor, the results of the HHRA indicated that cancer risks from exposure to surface soil and sediment were less than or within the risk management range (1×10^{-6} to 1×10^{-4}), and HIs were less than 1 in most areas of RASSs 1 through 4. The exceptions were Spatial Units 6 (central marsh surface soil), 7 (central marsh ditch sediment), 8 (RASS 1 active remediation area surface soil), and 11 (southwestern reach of Lost Slough), within RASS 1. Spatial Unit 8 abuts Spatial Unit 6 to the west, an area of particularly high contamination. Due to sampling design and subsequent errors, some samples that were supposed to be collected along the western boundary of Spatial Unit 8 were actually collected outside of the active remediation area (that is, in Unit 6). Concentrations of lead in soil and sediment were less than the EPA Region 9 PRG of 750 mg/kg at most locations within RASSs 1 through 4. However, concentrations were greater than the PRG at a few locations.

Tier 2 RBC Screen

The mosquito abatement worker was selected to represent the RME receptor at the Litigation Area under both current and expected future land use conditions. The results of the HHRA indicated that cancer risks from exposure to surface soil and sediment were less than or within the risk management range (1×10^{-6} to 1×10^{-4}), and HIs were less than 1 in most areas of RASSs 1 through 4. The exceptions were Spatial Units 6 (central marsh surface soil), 7 (central marsh ditch sediment), and 8 (RASS 1 active remediation area surface soil), where cancer risks were greater than 1×10^{-4} and HIs were greater than 1 at some sampling locations.

The Tier 2 screen evaluates risks at each sampling location. However, the mosquito abatement worker receptor would not be exposed at only a single location over the course of a year. That is, the worker would be exposed for only a short period of time at any one location while conducting inspection and spraying activities. Potential risks to the mosquito abatement worker are better interpreted using percentiles to describe the distribution of risks. The 50th and 95th percentile cancer risks were 1×10^{-5} and 1×10^{-4} at RASS 1, 6×10^{-6} and 5×10^{-5} at RASS 2, 1×10^{-6} and 1×10^{-5} at RASS 3, and 4×10^{-6} and 2×10^{-5} at RASS 4. HIs corresponding to the 95th percentile were less than 1 at all four RASSs. Cancer risks from incidental exposure to surface water were less than the lower end of the risk management range (1×10^{-6}), and HIs were less than 1 at all sampling locations.

Protectiveness of the Existing Remedy

A specific goal of the five-year review was to evaluate whether selected remedies, which included active remediation and the decision to leave some contamination in place (passive remediation), were protective of human health. Because an evaluation of protectiveness is related to land use, the discussion addresses

the protectiveness of the remedy under current site conditions (represented by the mosquito abatement worker scenario) and under the unlikely assumption that land use at the Litigation Area changes in the future (represented by the commercial/industrial worker and residential scenarios).

RASS 1

Spatial Unit 8 was the only area of active remediation in RASS 1. The estimated cancer risks and HIs for both current and possible future receptors in this area were less than the risk management range at all locations within this unit. A direct comparison with risks prior to remediation cannot be made because an HHRA was not previously conducted. However, a comparison of the risks in the area of active remediation with the risks in all other areas of RASS 1, indicates that remediation effectively reduced risks associated with potential exposures to soil. Spatial Unit 8 abuts Spatial Unit 6 to the west, an area of particularly high contamination; cancer risks were greater than the risk management range and HIs were greater than 1 at sampling locations at the interface of Spatial Units 6 and 8.

Passive remediation was the selected remedy in all other areas of RASS 1. Under current land use conditions, the cancer risks were within the risk management range and HIs were less than 1 at most locations. However, environmental conditions throughout extensive areas of RASS 1 may pose an unacceptable risk to human health if land use conditions were to change in the future, particularly if the area were developed for residential use. However, a future residential scenario is unlikely due to the wetland habitat and presence of endangered species in RASS 1.

RASS 2

Active remediation was conducted in the central portion of RASS 2. The estimated cancer risks for both current and possible future receptors in the northern portion of the remediated area were less than the risk management range and HIs were less than 1. Although a direct comparison cannot be made to risks prior to remediation, the remedy effectively reduced risks associated with potential exposures to soil in this area to levels that do not pose an unacceptable risk to human health. However, environmental conditions within some portions of both the active and passive remediation areas would pose an unacceptable risk to human health if land use conditions were to change in the future.

RASS 3

Active remediation was conducted throughout most of RASS 3 along Nichols Creek. Environmental conditions within both the active and passive remediation areas do not pose an unacceptable risk to

human health under current land use conditions. Under the assumption that land use conditions change in the future, areas remain in RASS 3 that may pose an unacceptable risk to human health.

RASS 4

Active remediation was conducted in two discrete areas of RASS 4. Environmental conditions in both the active and passive remediation areas do not pose an unacceptable risk to human health under current land use conditions. Under the assumption that land use conditions change in the future, areas remain in both the active and passive remediation areas that may pose an unacceptable risk to human health. Risks in the area of active remediation are not substantially different from those in the area of passive remediation.

6.0 CONCLUSIONS

The following conclusions are based on the findings of the Tier 1 PRG and Tier 2 RBC screens conducted for RASSs 1 through 4.

- **Risks to human health under current site conditions**: Under the assumption that current land use and site conditions remain unchanged and that adequate measures are in place to restrict access of unauthorized persons, the estimated cancer risks and noncancer HIs for current receptors, as represented by the mosquito abatement worker, are within or less than risk management levels. These findings indicate that current environmental conditions at the Litigation Area do not pose an unacceptable risk for continued use of this area as a buffer zone with restricted access.

- **Risks to human health under changed site conditions**: Under the assumption that land use changes in the future, the estimated cancer risks and noncancer HIs for resident and commercial/industrial worker receptors exceed risk management levels considered protective of human health in some portions of each of RASSs 1 through 4.

Preliminary risk management recommendations are provided in Section 10.0 of the five-year review report.

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ATTACHMENT F1

TABLES OF LOCATION-SPECIFIC RESULTS FOR THE TIER 1 AND TIER 2 RISK SCREENS

TABLE F1-1

LOCATION-SPECIFIC RESULTS FOR THE SOIL AND SEDIMENT
TIER 1 AND TIER 2 RISK SCREENS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	Tier 1				Tier 2	
	Residential Scenario		Industrial Worker Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
MHRSS001	6.48E-08	0.00351222	1.39E-08	0.00013939	--	--
MHRSS003	6.85E-05	1.9546923	1.00E-05	0.37837215	2.98E-06	0.01892857
MHRSS004	1.25E-04	2.2745046	1.81E-05	0.11310927	5.49E-06	0.03492857
MHRSS005	1.59E-07	0.30026461	1.02E-09	0.01386715	--	--
R01DH009	7.31E-05	1.5611916	1.06E-05	0.0772367	3.20E-06	0.02035714
R01DH018	1.31E-04	2.7688589	1.89E-05	0.13714024	5.72E-06	0.03635714
R01DH019	2.57E-04	5.2122514	3.72E-05	0.52045666	0.00001124	0.07142857
R01DH020	9.17E-05	1.8293506	1.32E-05	0.09436309	3.94E-06	0.02507143
R01DH021	9.08E-05	2.3628259	1.31E-05	0.11494121	3.97E-06	0.02521429
R01DH026	7.87E-05	2.2711258	1.14E-05	0.42800687	3.38E-06	0.0215
R01DH027	6.72E-05	1.338968	9.67E-06	0.07047475	2.93E-06	0.01864286
R01DH030	7.53E-07	0.81434275	2.35E-07	0.3465094	--	--
R01DH035	7.96E-05	1.5830781	1.15E-05	0.08213991	3.47E-06	0.02207143
R01DH040	6.67E-07	0.66073622	1.88E-07	0.29815988	--	--
R01DH041	1.88E-04	3.6114868	2.70E-05	0.18803502	8.19E-06	0.05207143
R01DH049	2.73E-04	5.1614412	3.93E-05	0.26983938	0.00001191	0.07571429
R01DH052	2.27E-04	4.4857247	3.27E-05	0.24338453	9.91E-06	0.063
R01DH056	9.90E-05	1.7761542	1.43E-05	0.09269727	4.34E-06	0.02757143
R01DH057	2.42E-04	4.8223095	3.48E-05	0.25382728	0.00001055	0.06707143
R01DH061	2.29E-04	4.4103547	3.29E-05	0.23292164	9.99E-06	0.0635
R01DH066	8.91E-05	1.7044088	1.28E-05	0.09148735	3.89E-06	0.02471429
R01DH067	8.36E-03	148.9014	1.21E-03	7.4550205	0.00036629	2.3285714
R01DH073	2.59E-04	4.9061707	3.74E-05	0.24869641	0.00001135	0.07214286
R01DH086	1.60E-04	4.4461935	2.29E-05	0.23229458	6.96E-06	0.05385714
R01DH087	1.05E-04	2.03356	1.51E-05	0.11171613	4.58E-06	0.02914286
R01DH090	5.38E-04	10.404737	7.74E-05	0.54098793	0.00002348	0.14928571
R01DH092	7.09E-04	12.959424	1.02E-04	0.65663348	0.00003101	0.19714286
R01DH096	1.79E-04	3.9542134	2.55E-05	0.21980181	7.73E-06	0.04914286
R01DH099	4.76E-04	9.0283397	6.88E-05	0.46068708	0.00002086	0.13142857
R01DH100	2.38E-03	42.823132	3.44E-04	2.1575605	0.00010427	0.66285714
R01DH113	9.37E-04	17.38427	1.35E-04	0.87840153	0.00004101	0.26071429
R01DH117	3.78E-07	0.25723307	1.13E-09	0.0326149	--	--
R01DH120	1.07E-03	20.010481	1.54E-04	1.019697	0.00004674	0.29714286
R01DH121	2.63E-04	5.1862563	3.78E-05	0.2721818	0.00001146	0.07285714
R01DH124	7.03E-05	1.6098902	1.00E-05	0.0933443	3.03E-06	0.01928571
R01DH240	9.39E-04	16.933926	1.36E-04	0.85378906	0.00004112	0.26142857
R01DH241	1.46E-03	26.570189	2.11E-04	1.3505195	0.00006405	0.40714286
R01DH248	7.26E-04	13.071397	1.05E-04	0.66301826	0.0000318	0.20214286
R01DH249	2.85E-03	50.90446	4.11E-04	2.5496287	0.00012472	0.79285714
R01DH250	1.34E-03	24.231529	1.94E-04	1.2183444	0.00005888	0.37428571
R01DH259	4.49E-04	8.4553414	6.48E-05	0.42847553	0.00001966	0.125
R01DH260	5.42E-04	9.91784	7.82E-05	0.50398194	0.00002371	0.15071429
R01DH261	1.21E-03	22.069466	1.75E-04	1.1077285	0.00005315	0.33785714
R01DH263	2.52E-04	4.7255284	3.64E-05	0.24270715	0.00001103	0.07014286
R01DH265	1.10E-03	24.236933	1.56E-04	1.2796701	0.00004742	0.33752613
R01DH266	4.54E-03	82.220207	6.56E-04	4.1334645	0.00019888	1.2740662
R01SH012	1.85E-04	3.3227612	2.67E-05	0.16783854	8.11E-06	0.05157143
R01SH013	--	0.01797101	--	0.00286	--	--
R01SH015	2.10E-04	3.8740929	3.03E-05	0.19645566	9.20E-06	0.0585
R01SH023	1.70E-06	0.74940206	4.44E-07	0.36500993	--	--
R01SH028	2.42E-04	4.6547792	3.49E-05	0.23437167	0.00001058	0.06728571
R01SH029	2.41E-04	5.0073139	3.49E-05	0.53093546	0.00001053	0.06692857
R01SH033	1.27E-04	2.3630718	1.83E-05	0.12022303	5.56E-06	0.03535714
R01SH038	6.88E-07	0.20960335	1.87E-07	0.01190335	--	--
R01SH043	5.05E-07	0.63939647	1.97E-07	0.30531793	--	--

TABLE F1-1 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SOIL AND SEDIMENT
TIER 1 AND TIER 2 RISK SCREENS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	Tier 1				Tier 2	
	Residential Scenario		Industrial Worker Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R01SH046	5.24E-04	10.120289	7.58E-05	0.82032023	0.00002292	0.14571429
R01SH048	4.66E-07	0.69227029	2.17E-07	0.34001386	--	--
R01SH050	2.38E-04	4.9101574	3.43E-05	0.26659842	0.00001029	0.06542857
R01SH051	1.25E-03	22.431855	1.80E-04	1.130611	0.00005472	0.34785714
R01SH055	5.39E-04	10.403049	7.78E-05	0.78012054	0.0000236	0.15
R01SH058	9.44E-04	17.695246	1.37E-04	1.1678961	0.00004135	0.26285714
R01SH065	4.11E-07	0.1233913	1.23E-09	0.0099479	--	--
R01SH074	2.72E-04	7.6794177	3.84E-05	0.81482384	0.00001157	0.08903484
R01SH075	1.16E-03	23.359383	1.67E-04	1.5784785	0.00005068	0.33770383
R01SH077	2.72E-03	49.476497	3.93E-04	2.5140359	0.0001191	0.75714286
R01SH081	3.93E-04	10.277655	5.52E-05	0.61680883	0.00001674	0.1293554
R01SH082	4.30E-04	9.2822942	6.15E-05	0.53572754	0.00001865	0.12776655
R01SH097	2.57E-04	8.2307402	3.56E-05	0.51252866	0.00001082	0.09427003
R01SH098	6.84E-04	13.809563	9.82E-05	0.78123769	0.00002978	0.19913937
R01SH105	1.62E-04	3.6433958	2.31E-05	0.2007958	7.00E-06	0.0445
R01SH111	2.37E-04	8.4297988	3.24E-05	0.77687459	9.75E-06	0.09217247
R01SH112	1.58E-04	3.5665965	2.25E-05	0.21478006	6.82E-06	0.04335714
R01SH118	5.45E-04	10.582704	7.87E-05	0.83553996	0.00002382	0.15142857
R01SH130	8.50E-04	16.113077	1.23E-04	1.1276557	0.00003719	0.23642857
R01SH131	1.92E-04	4.7931816	2.76E-05	0.74318455	8.38E-06	0.05328571
R01SH132	1.42E-04	3.2309654	2.04E-05	0.19681406	6.18E-06	0.03928571
R01SH133	1.28E-04	2.7703021	1.83E-05	0.15869541	5.56E-06	0.03535714
R01SH134	2.91E-04	6.4642124	4.21E-05	0.64598939	0.0000127	0.08071429
R01SH206	9.22E-05	1.7394051	1.33E-05	0.08901546	4.03E-06	0.02564286
R01SH217	7.33E-07	0.009019	1.47E-07	0.00063308	--	--
R01SH219	--	0.00794872	--	0.00031	--	--
R01SH220	7.81E-05	1.5963802	1.12E-05	0.08456975	3.39E-06	0.02157143
R01SH221	9.84E-05	1.9233265	1.42E-05	0.10095916	4.29E-06	0.02728571
R01SH222	7.47E-05	1.400125	1.08E-05	0.0719786	3.27E-06	0.02078571
R01SH223	1.19E-04	2.2172312	1.72E-05	0.11294278	5.21E-06	0.03314286
R01SH224	1.84E-04	3.4108143	2.66E-05	0.17507555	8.06E-06	0.05121429
R01SH225	1.81E-04	3.2917789	2.61E-05	0.1662789	7.92E-06	0.05035714
R01SH226	1.88E-04	3.4291494	2.72E-05	0.17337082	8.25E-06	0.05242857
R01SH227	9.80E-05	1.7657053	1.42E-05	0.08811053	4.29E-06	0.02728571
R01SH228	8.84E-05	1.6863764	1.27E-05	0.08756967	3.87E-06	0.02457143
R01SH229	7.82E-05	1.6033254	1.12E-05	0.08802356	3.40E-06	0.02164286
R01SH230	8.37E-05	1.5525356	1.21E-05	0.07904837	3.66E-06	0.02328571
R01SH231	1.19E-04	2.2663906	1.71E-05	0.11679305	5.18E-06	0.03292857
R01SH234	1.00E-04	1.9038865	1.44E-05	0.09706296	4.37E-06	0.02778571
R01SH235	2.52E-04	4.8817996	3.63E-05	0.25610824	0.00001102	0.07007143
R01SH236	9.77E-05	3.5702887	1.31E-05	0.19003705	3.97E-06	0.04104355
R01SH237	1.58E-04	2.8644098	2.28E-05	0.14516717	6.91E-06	0.04392857
R01SH239	1.71E-04	3.6227548	2.46E-05	0.20095097	7.45E-06	0.04735714
R01SH243	3.19E-04	6.1828999	4.59E-05	0.32932569	0.00001393	0.08857143
R01SH244	7.90E-04	23.040379	1.09E-04	1.3374858	0.00003316	0.29582217
R01SH245	4.28E-04	9.0859096	6.11E-05	0.51390512	0.00001854	0.12763763
R01SH247	3.20E-04	6.5511601	4.59E-05	0.3853425	0.00001393	0.08857143
R01SH251	8.87E-04	40.869774	1.15E-04	2.6403559	0.00003486	0.45870155
R01SH252	2.12E-04	4.5390706	3.03E-05	0.25201047	9.20E-06	0.0585
R01SH254	1.31E-03	27.032643	1.88E-04	1.4901714	0.00005708	0.38993031
R01SH255	8.13E-04	14.566658	1.17E-04	0.73229553	0.00003562	0.22642857
R01SH256	7.23E-04	13.577147	1.04E-04	0.6987673	0.00003157	0.20071429
R01SH257	5.85E-04	10.613037	8.45E-05	0.535846	0.00002562	0.16285714
R01SS001	1.36E-04	2.4181818	1.97E-05	0.12090909	5.98E-06	0.038
R01SS002	1.33E-07	0.03679141	4.00E-10	0.00165148	--	--

TABLE F1-1 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SOIL AND SEDIMENT
TIER 1 AND TIER 2 RISK SCREENS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	Tier 1				Tier 2	
	Residential Scenario		Industrial Worker Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R01SS006	1.23E-04	2.2487215	1.77E-05	0.1136035	5.38E-06	0.03421429
R01SS008	1.44E-07	0.04128898	4.33E-10	0.00184494	--	--
R01SS009	1.56E-07	0.25977071	4.67E-10	0.0103958	--	--
R01SS010	8.50E-05	1.7672566	1.23E-05	0.08572637	7.44E-06	0.04728571
R01SS011	1.89E-04	4.2074721	2.75E-05	0.51986419	8.27E-06	0.05257143
R01SS014	--	0.0267931	--	0.00102237	--	--
R01SS016	2.82E-10	0.24711193	1.41E-10	0.00961238	--	--
R01SS017	1.16E-04	2.788211	1.68E-05	0.50213893	5.05E-06	0.03207143
R01SS024	1.26E-06	0.87541585	2.38E-07	0.41995555	--	--
R01SS025	1.95E-04	3.5275567	2.81E-05	0.1793953	8.53E-06	0.05421429
R01SS031	1.80E-04	3.245716	2.60E-05	0.16435266	7.88E-06	0.05007143
R01SS032	1.69E-04	3.0045455	2.45E-05	0.15022727	7.43E-06	0.04721429
R01SS034	1.44E-07	0.08970612	4.33E-10	0.00689731	--	--
R01SS037	3.13E-04	5.6807519	4.52E-05	0.28772293	0.00001371	0.08714286
R01SS039	--	0.01182609	--	0.00272	--	--
R01SS042	1.89E-04	3.5437172	2.73E-05	0.18165237	8.28E-06	0.05264286
R01SS044	1.35E-06	0.74983578	4.12E-07	0.38249728		
R01SS045	1.58E-04	2.9628603	2.29E-05	0.14865855	6.93E-06	0.04407143
R01SS047	5.10E-03	90.627674	7.37E-04	4.5327783	0.0002236	1.4214286
R01SS053	1.33E-07	0.07941352	4.00E-10	0.00512911	--	--
R01SS054	1.67E-07	0.06743709	5.00E-10	0.00287817	--	--
R01SS059	--	0.02282051	--	0.00089	--	--
R01SS060	1.65E-04	3.0282811	2.39E-05	0.15745144	7.25E-06	0.04607143
R01SS062	7.75E-04	14.353145	1.12E-04	0.72266741	0.00003393	0.21571429
R01SS063	1.56E-07	0.06438956	4.67E-10	0.00274155	--	--
R01SS064	--	--	--	0.00098553	--	--
R01SS069	1.56E-07	0.03783784	4.67E-10	0.0017284	--	--
R01SS070	1.44E-07	0.06490171	4.33E-10	0.00274336	--	--
R01SS071	1.72E-04	3.156381	2.49E-05	0.1649486	7.57E-06	0.0475
R01SS072	3.46E-04	6.225854	5.00E-05	0.31294075	0.00001517	0.09642857
R01SS076	9.67E-04	17.483301	1.40E-04	0.87349744	0.00004236	0.26928571
R01SS078	4.62E-03	83.089539	6.67E-04	4.4668255	0.00020225	1.2857143
R01SS079	7.05E-05	1.3219558	1.02E-05	0.06554044	3.08E-06	0.01957143
R01SS080	1.33E-07	0.05923261	4.00E-10	0.00250511	--	--
R01SS083	5.03E-03	90.153767	7.26E-04	4.5106287	0.00022023	1.4
R01SS084	1.62E-03	29.663241	2.34E-04	1.7514934	0.00007101	0.45142857
R01SS088	5.00E-04	9.316472	7.22E-05	0.4634646	0.00002191	0.13928571
R01SS089	1.40E-03	25.058003	2.02E-04	1.2640272	0.00006124	0.38928571
R01SS091	3.26E-03	58.163203	4.70E-04	2.9107355	0.0001427	0.90714286
R01SS093	1.11E-07	0.05865656	3.33E-10	0.00244315	--	--
R01SS094	1.67E-07	0.06785089	5.00E-10	0.00289396	--	--
R01SS095	3.52E-04	7.761601	5.08E-05	0.40512218	0.00001539	0.10844538
R01SS101	1.67E-07	0.06788537	5.00E-10	0.00289527	--	--
R01SS102	1.27E-04	2.5121646	1.83E-05	0.14645092	5.56E-06	0.03535714
R01SS103	9.88E-04	23.884611	1.43E-04	1.5116133	0.00004326	0.33158824
R01SS104	4.90E-04	9.5023613	7.07E-05	0.79288253	0.00002146	0.13642857
R01SS106	1.81E-03	32.264508	2.61E-04	1.6184362	0.00007921	0.50357143
R01SS107	1.07E-03	19.366474	1.55E-04	0.9699855	0.00004697	0.29857143
R01SS108	3.21E-03	57.413955	4.63E-04	2.8712862	0.00014045	0.89285714
R01SS109	3.17E-04	6.4191103	4.56E-05	0.35532541	0.00001382	0.08785714
R01SS110	--	0.02851724	--	0.00108816	--	--
R01SS114	--	0.02603448	--	0.00099342	--	--
R01SS116	1.67E-07	0.07917172	5.00E-10	0.00528606	--	--
R01SS119	6.64E-04	12.119957	9.59E-05	0.61434618	0.0000291	0.185
R01SS122	1.56E-07	0.06944438	4.67E-10	0.00293582		

TABLE F1-1 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SOIL AND SEDIMENT
TIER 1 AND TIER 2 RISK SCREENS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	Tier 1				Tier 2	
	Residential Scenario		Industrial Worker Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R01SS125	6.72E-04	12.106539	9.70E-05	0.60800722	0.00002944	0.18714286
R01SS126	2.11E-07	0.10131771	6.33E-10	0.0072731	--	--
R01SS127	1.89E-07	0.07796893	5.67E-10	0.0033235	--	--
R01SS128	2.32E-03	41.853546	3.34E-04	2.0934682	0.00010146	0.645
R01SS129	--	0.0297931	--	0.00113684	--	--
R01SS135	2.63E-04	5.4169331	3.78E-05	0.30972054	0.00001146	0.07285714
R01SS138	2.00E-04	3.8303437	2.88E-05	0.20097406	8.73E-06	0.0555
R01SS143	7.48E-05	1.5215439	1.07E-05	0.08169331	3.26E-06	0.02071429
R01SS232	9.69E-05	1.8147255	1.40E-05	0.09214111	4.24E-06	0.02692857
R01SS233	7.76E-05	1.4078416	1.12E-05	0.07020439	3.39E-06	0.02157143
R01SS238	1.04E-04	1.8914212	1.50E-05	0.0961101	4.56E-06	0.029
R01SS242	1.56E-04	2.9336509	2.24E-05	0.16464161	6.81E-06	0.04328571
R01SS246	2.85E-04	5.1610246	4.11E-05	0.26126314	0.00001247	0.07928571
R01SS253	1.63E-03	29.326075	2.36E-04	1.4749306	0.00007146	0.45428571
R01SS258	5.90E-04	10.669375	8.52E-05	0.5399107	0.00002584	0.16428571
R01SS262	2.13E-04	4.0729817	3.07E-05	0.22750563	9.33E-06	0.05928571
R01SS264	2.85E-03	51.335868	4.11E-04	2.5711614	0.00012472	0.79285714
R02SS135	9.95E-05	2.5159381	1.42E-05	0.16735237	4.30E-06	0.02735714
R02SS136	4.22E-07	0.14246328	1.27E-09	0.00799609	--	--
R02SS137	3.53E-04	6.8822851	5.07E-05	0.36117205	0.00001539	0.09785714
R02SS139	2.33E-07	0.10444991	7.00E-10	0.00762654	--	--
R02SS140	1.67E-07	0.08417234	5.00E-10	0.00551369	--	--
R02SS141	1.33E-07	0.06619901	4.00E-10	0.00277253	--	--
R02SS142	1.12E-04	2.114227	1.61E-05	0.11059725	4.89E-06	0.03107143
R02SS144	1.65E-04	3.4776054	2.36E-05	0.18438726	7.15E-06	0.04542857
R02SS145	1.33E-07	0.08854376	4.00E-10	0.00774517	--	--
R02SS146	1.56E-07	0.08644707	4.67E-10	0.00708945	--	--
R02SS147	1.03E-07	0.0408319	3.10E-10	0.00448415	--	--
R02SS148	9.57E-05	2.3632234	1.36E-05	0.15431725	4.12E-06	0.02621429
R02SS149	5.94E-04	12.246342	8.52E-05	0.68902923	0.00002584	0.17370035
R02SS150	5.45E-04	10.355414	7.85E-05	0.54587449	0.00002382	0.15142857
R02SS151	2.02E-07	0.11010615	1.01E-09	0.00658084	--	--
R02SS207	1.06E-07	0.19428379	3.17E-10	0.01042679	--	--
R02SS267	1.35E-03	24.272676	1.96E-04	1.2265886	0.00005933	0.37714286
R02SS268	1.05E-04	2.1624919	1.50E-05	0.11525926	4.56E-06	0.029
R02SS269	8.87E-04	16.141571	1.28E-04	0.81182247	0.00003888	0.24714286
R02SS271	9.93E-05	2.499271	1.42E-05	0.17472307	4.29E-06	0.02728571
R02SS272	7.23E-05	1.440669	1.04E-05	0.07891611	3.16E-06	0.02007143
R03SH158	2.22E-07	0.09747434	6.67E-10	0.01181914	--	--
R03SH159	4.88E-04	8.8202914	7.04E-05	0.44569324	0.00002135	0.13571429
R03SH160	4.44E-07	0.20087511	1.33E-09	0.02591227	--	--
R03SH161	5.35E-05	1.1289938	7.67E-06	0.07165736	2.33E-06	--
R03SH162	2.89E-07	0.1300473	8.67E-10	0.01641988	--	--
R03SH163	4.33E-07	0.21929615	1.30E-09	0.03076481	--	--
R03SH165	4.55E-05	1.0595674	6.48E-06	0.07411594	1.97E-06	--
R03SH169	2.22E-07	0.11075862	6.67E-10	0.01522714	--	--
R03SH181	3.64E-05	1.1244025	5.11E-06	0.09328231	1.55E-06	--
R03SH184	2.72E-05	0.73225001	3.85E-06	0.05847575	1.17E-06	--
R03SH185	2.48E-05	0.80288344	3.48E-06	0.07849813	1.06E-06	--
R03SH186	4.83E-05	2.1760886	6.67E-06	0.23679971	2.02E-06	--
R03SH187	1.76E-06	0.58946292	5.27E-09	0.05640117	4.79E-10	--
R03SH189	1.44E-07	0.0913804	4.33E-10	0.01417894	--	--
R03SH270	5.04E-05	1.6601897	7.04E-06	0.13601876	2.14E-06	--
R03SH273	1.28E-04	2.7578727	1.83E-05	0.16710882	5.55E-06	0.03528571
R03SH274	4.61E-05	0.9070468	6.63E-06	0.0519175	2.01E-06	--

TABLE F1-1 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SOIL AND SEDIMENT
TIER 1 AND TIER 2 RISK SCREENS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	Tier 1				Tier 2	
	Residential Scenario		Industrial Worker Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R03SH275	3.82E-05	1.0378876	5.37E-06	0.06903017	1.63E-06	--
R03SH276	3.77E-05	0.78287286	5.41E-06	0.04910787	1.64E-06	--
R03SH277	6.78E-07	0.25123722	2.03E-09	0.02709286	--	--
R03SH278	4.59E-04	8.3724414	6.63E-05	0.43055247	0.00002011	0.12785714
R03SH279	2.52E-05	0.6216	3.59E-06	0.04333425	1.09E-06	--
R03SH280	2.00E-07	0.09653048	6.00E-10	0.01289222	--	--
R03SH281	2.56E-07	0.11863931	7.67E-10	0.01533951	--	--
R03SH282	6.22E-07	0.53815737	1.87E-09	0.09565858	--	--
R03SH283	2.19E-05	0.92450299	3.04E-06	0.09649862	9.21E-07	--
R03SH284	3.56E-07	0.28521224	1.07E-09	0.04931962	--	--
R03SH285	1.78E-08	0.01522733	5.33E-11	0.00211753	--	--
R03SH286	7.11E-08	0.03983576	2.13E-10	0.00548912	--	--
R03SS158	1.33E-07	0.07404113	4.00E-10	0.01105148	--	--
R03SS160	5.56E-07	0.24687427	1.67E-09	0.03187284	--	--
R03SS161	--	0.02126087	--	0.00489	--	--
R03SS162	1.92E-05	0.44970089	2.74E-06	0.03441695	8.32E-07	--
R03SS163	6.56E-07	0.21641598	1.97E-09	0.02038395	--	--
R03SS164	2.36E-05	0.42439921	3.41E-06	0.02233909	1.03E-06	--
R03SS165	4.23E-05	1.9245255	5.86E-06	0.2161303	1.78E-06	--
R03SS167	--	0.00094872	--	0.000037	--	--
R03SS168	7.00E-08	0.02677508	2.10E-10	0.00273578	--	--
R03SS169	9.92E-06	0.57315255	2.11E-06	0.04919324	7.46E-07	--
R03SS170	3.03E-05	0.54349407	4.37E-06	0.02845818	1.33E-06	--
R03SS171	2.78E-05	0.51419268	4.00E-06	0.02654354	1.21E-06	--
R03SS172	--	0.007	--	0.00161	--	--
R03SS173	1.90E-05	0.33723543	2.74E-06	0.01685218	8.32E-07	--
R03SS174	5.91E-10	0.36832325	2.96E-10	0.24741476	--	--
R03SS175	--	0.00582513	--	0.00095044	--	--
R03SS176	3.63E-05	0.89075786	5.23E-06	0.05266572	1.58E-06	--
R03SS177	5.11E-08	0.03757625	1.53E-10	0.00151754	--	--
R03SS178	--	0.2834991	--	0.21201131	--	--
R03SS179	2.17E-05	0.48029665	3.11E-06	0.03245837	9.44E-07	--
R03SS180	7.00E-08	0.04654877	2.10E-10	0.00756778	--	--
R03SS181	3.66E-05	1.0600908	5.15E-06	0.08625511	1.56E-06	--
R03SS182	3.78E-07	0.52448395	1.42E-09	0.2470161	--	--
R03SS183	3.44E-05	0.61299091	4.96E-06	0.03135155	1.51E-06	--
R03SS184	2.43E-05	0.500241	3.48E-06	0.03117203	1.06E-06	--
R03SS185	--	0.00411304	--	0.000946	--	--
R03SS186	2.06E-05	0.66489798	2.89E-06	0.06420011	8.76E-07	--
R03SS188	--	0.01030435	--	0.00237	--	--
R03SS190	--	0.01347826	--	0.0031	--	--
R03SS214	8.14E-06	1.3844363	1.76E-06	0.10857916	6.90E-07	0.04166667
R03SS215	3.23E-07	0.06501674	7.06E-08	0.0050924	--	--
R03SS216	3.62E-06	0.57716802	7.76E-07	0.04521233	2.48E-07	--
R03WD152	2.41E-04	4.9949048	3.46E-05	0.28660332	0.00001048	0.06664286
R03WD153	3.44E-05	1.6560666	4.86E-06	0.37718452	1.43E-06	--
R03WD154	2.69E-05	1.3279385	3.95E-06	0.38767066	1.14E-06	--
R03WD155	4.21E-05	4.1832144	5.36E-06	0.85521507	1.55E-06	0.02246998
R03WD156	6.42E-05	2.5665706	9.15E-06	0.50062467	2.72E-06	0.01728571
R03WD157	3.43E-05	1.5628867	4.98E-06	0.40954385	1.47E-06	--
R04SS191	2.60E-04	4.7940128	3.74E-05	0.24035089	0.00001135	0.07214286
R04SS192	5.31E-04	10.033603	7.63E-05	0.50080666	0.00002315	0.14714286
R04SS193	1.74E-04	3.4149727	2.49E-05	0.17096093	7.56E-06	0.04807143
R04SS194	2.14E-04	4.4037408	3.08E-05	0.2151872	9.34E-06	0.05935714
R04SS196	8.82E-05	1.8782234	1.26E-05	0.09400498	3.81E-06	0.02421429

TABLE F1-1 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SOIL AND SEDIMENT
TIER 1 AND TIER 2 RISK SCREENS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

	Tier 1				Tier 2	
	Residential Scenario		Industrial Worker Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R04SS197	9.18E-05	1.7433792	1.32E-05	0.08821806	4.01E-06	0.0255
R04SS198	1.89E-04	7.4891444	2.71E-05	0.53679533	8.23E-06	0.08248786
R04SS200	3.09E-04	13.235664	4.45E-05	0.57091783	0.00001348	0.15192359
R04SS201	7.94E-05	3.5872828	1.13E-05	0.15543271	3.44E-06	0.03893407
R04SS202	1.19E-04	3.4394335	1.72E-05	0.15916407	5.20E-06	0.03307143
R04SS208	3.34E-04	6.3688576	4.83E-05	0.31631093	0.00001461	0.09285714
R04SS209	7.51E-05	1.7622954	1.08E-05	0.08464681	3.27E-06	0.02078571
R04SS210	1.05E-04	2.3500814	1.50E-05	0.11345958	4.56E-06	0.029
R04WD195	4.94E-05	1.147936	7.04E-06	0.0583935	2.14E-06	--
R04WD199	3.30E-05	1.0527364	4.75E-06	0.2428065	1.43E-06	--
R04WD203	3.42E-05	0.76691703	4.93E-06	0.03953721	1.49E-06	--
R04WD204	2.41E-05	0.85722549	3.49E-06	0.24182001	1.05E-06	--
R04WD205	3.40E-05	0.65598704	4.89E-06	0.03482496	1.48E-06	--
R04WD211	1.73E-08	0.00014373	3.36E-09	8.25E-06	--	--
R04WD212	1.84E-07	0.0109358	2.61E-08	0.0005455	--	--
R04WD213	2.23E-08	0.00106984	3.24E-09	0.00005543	--	--
UDRSH002	--	0.00092308	--	0.000036	--	--
UDRSH006	--	0.00084615	--	0.000033	--	--
UDRSH287	3.56E-08	0.01326403	1.07E-10	0.00057506	--	--
UDRSS001	7.03E-08	0.023799	2.48E-10	0.00198041	--	--
UDRSS003	4.51E-08	0.01501361	3.03E-09	0.00147816	--	--
UDRSS004	1.95E-05	0.40620041	2.82E-06	0.0213377	8.54E-07	--
UDRSS005	6.07E-08	0.01653749	3.52E-09	0.0018168	--	--
UDRSS007	5.71E-08	0.01777489	2.61E-09	0.00167428	--	--

Notes:

-- A risk was not calculated for this location because the chemical concentrations did not exceed the ambient screen (for Tier 1) or the ambient and PRG screen for (Tier 2) or because PRGs were not available for the detected chemicals.

PRG Preliminary remediation goal

TABLE F1-2

LOCATION-SPECIFIC RESULTS FOR THE SURFACE WATER TIER 1 AND TIER 2 RISK SCREENS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

	Tier 1		Tier 2	
	Resident Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R01AG002	1.56E-03	70.048777	9.25E-08	0.0065621
R01AG003	1.56E-03	81.205135	9.25E-08	0.0076127
R01AG004	1.56E-03	54.121189	9.25E-08	0.0051436
R01DH018	--	0.00251818	--	--
R01DH019	1.02E-04	0.41980242	6.08E-09	0.0000135
R01DH020	1.31E-04	0.00566364	7.79E-09	0.0000173
R01DH021	8.58E-04	0.46097328	5.10E-08	0.0001132
R01DH026	1.02E-04	0.83716581	6.08E-09	0.0000135
R01DH027	1.36E-04	0.53240777	8.06E-09	0.0000179
R01DH030	1.27E-04	1.2972687	7.53E-09	0.0000167
R01DH035	4.56E-03	17.81916	2.71E-07	0.0019657
R01DH040	9.11E-04	0.36131313	5.42E-08	0.0001202
R01DH041	7.07E-04	0.07893506	4.20E-08	0.0000933
R01DH049	3.31E-03	13.14108	1.97E-07	0.0013761
R01DH052	3.16E-03	1.2415584	1.88E-07	0.0004164
R01DH056	8.71E-04	2.2666998	5.18E-08	0.0002395
R01DH057	2.67E-03	0.32377706	1.59E-07	0.0003519
R01DH061	8.89E-04	0.03816883	5.28E-08	0.0001173
R01DH066	7.20E-04	2.6830895	4.28E-08	0.0002262
R01DH067	7.07E-03	0.48574026	4.20E-07	0.0009326
R01DH073	1.97E-03	0.04258442	1.17E-07	0.0002601
R01DH090	7.82E-04	0.05681097	4.65E-08	0.0001032
R01DH092	3.33E-02	6.2819695	1.98E-06	0.0048415
R01DH096	2.14E-03	2.0078644	1.27E-07	0.0003914
R01DH099	3.47E-04	0.09686075	2.06E-08	0.0000457
R01DH100	4.71E-03	0.89186869	2.80E-07	0.0006217
R01DH113	7.98E-04	0.04159091	4.74E-08	0.0001053
R01DH117	1.29E-04	0.09106854	7.66E-09	0.000017
R01DH120	6.60E-02	19.498701	3.92E-06	0.0104705
R01DH121	7.22E-03	19.875346	4.29E-07	0.0025423
R01DH124	2.02E-04	0.08043001	1.20E-08	0.0000267
R01DH240	2.49E-02	3.4123737	1.48E-06	0.0035458
R01DH241	2.51E-03	0.01554545	1.49E-07	0.0003314
R01DH248	4.16E-03	0.19409091	2.47E-07	0.0005484
R01DH249	1.38E-04	0.01550649	8.19E-09	0.0000182
R01DH250	1.27E-03	0.06289899	7.54E-08	0.0001674
R01DH259	9.51E-04	0.07267027	5.65E-08	0.0001255
R01DH260	9.51E-04	0.03498701	5.65E-08	0.0001255
R01DH261	3.96E-03	0.55390332	2.35E-07	0.000522
R01DH263	1.10E-03	0.20822799	6.53E-08	0.0001449
R01DH265	3.20E-03	1.8222583	1.90E-07	0.0004223
R01DH266	5.80E-02	30.880122	3.45E-06	0.0102612
R01MG001	1.33E-03	68.105854	7.93E-08	0.0063488
R01PG005	2.22E-04	130.80581	1.32E-08	0.0120585
R01PG018	3.18E-04	74.991333	1.85E-08	0.0069426

TABLE F1-2 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SURFACE WATER TIER 1 AND TIER 2 RISK SCREENS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

	Tier 1		Tier 2	
	Resident Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R01SH012	6.89E-05	0.00633636	4.10E-09	0.00000909
R01SH013	--	0.02398701	--	--
R01SH015	1.58E-04	0.00945455	9.38E-09	0.0000208
R01SH023	6.93E-04	0.56136414	4.12E-08	0.0000915
R01SH028	1.67E-04	0.39538194	9.91E-09	0.000022
R01SH029	2.10E-04	0.32534338	1.15E-08	0.0000255
R01SH033	1.24E-04	0.3714907	7.40E-09	0.0000164
R01SH043	--	0.26021522	--	--
R01SH046	1.09E-04	0.01956364	6.47E-09	0.0000144
R01SH050	1.02E-04	0.00554545	6.08E-09	0.0000135
R01SH051	--	0.02038961	--	--
R01SH055	1.92E-03	1.1743579	1.14E-07	0.0002537
R01SH058	4.67E-04	0.04380736	2.77E-08	0.0000616
R01SH074	2.67E-04	0.82768329	1.59E-08	0.0000352
R01SH075	--	0.43877234	--	--
R01SH077	5.31E-03	2.6056349	3.16E-07	0.0008286
R01SH081	1.04E-02	9.570938	6.18E-07	0.00212
R01SH082	1.15E-02	12.404414	6.84E-07	0.0024557
R01SH097	2.93E-04	0.82164658	1.74E-08	0.0000387
R01SH098	3.87E-04	0.04642569	2.30E-08	0.000051
R01SH105	3.20E-04	0.14383117	1.90E-08	0.0000422
R01SH111	5.64E-04	0.04414719	3.36E-08	0.0000745
R01SH112	1.16E-04	0.07920058	6.87E-09	0.0000152
R01SH118	3.09E-04	0.84556362	1.84E-08	0.0000408
R01SH130	9.33E-05	0.16174711	5.55E-09	0.0000123
R01SH131	9.78E-05	0.26196622	5.81E-09	0.0000129
R01SH132	1.40E-04	0.07844661	8.32E-09	0.0000185
R01SH133	6.67E-03	3.5392525	3.96E-07	0.0010135
R01SH134	1.49E-04	0.42524937	8.85E-09	0.0000196
R01SH206	--	0.03564935	--	--
R01SH219	--	0.00248182	--	--
R01SH220	1.02E-04	0.00405455	6.08E-09	0.0000135
R01SH221	6.67E-05	0.01231948	3.96E-09	0.0000088
R01SH222	6.89E-05	0.01354675	4.10E-09	0.00000909
R01SH223	1.00E-04	0.00823636	5.94E-09	0.0000132
R01SH224	1.40E-04	0.01672857	8.32E-09	0.0000185
R01SH225	1.00E-04	0.01727273	5.94E-09	0.0000132
R01SH226	2.02E-04	0.00155455	1.20E-08	0.0000267
R01SH227	--	0.03985714	--	--
R01SH228	3.22E-04	0.56373312	1.92E-08	0.0000425
R01SH229	1.09E-04	0.01066104	6.47E-09	0.0000144
R01SH230	1.18E-04	0.01411948	7.00E-09	0.0000155
R01SH231	5.47E-04	0.04157143	3.25E-08	0.0000721
R01SH234	1.38E-04	1.2424637	8.19E-09	0.0000182
R01SH235	1.22E-04	0.00534545	7.27E-09	0.0000161

TABLE F1-2 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SURFACE WATER TIER 1 AND TIER 2 RISK SCREENS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

	Tier 1		Tier 2	
	Resident Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R01SH236	1.33E-04	0.00469091	7.93E-09	0.0000176
R01SH237	6.89E-05	0.04080664	4.10E-09	0.00000909
R01SH239	--	0.02439538	--	--
R01SH243	--	0.01303896	--	--
R01SH244	2.53E-04	1.0508641	1.51E-08	0.0000334
R01SH245	3.20E-04	0.0987785	1.90E-08	0.0000422
R01SH247	2.04E-04	0.05113636	1.22E-08	0.000027
R01SH251	3.33E-04	0.97136797	1.98E-08	0.000044
R01SH252	2.11E-04	0.03052597	1.25E-08	0.0000279
R01SH254	1.02E-04	0.03003247	6.08E-09	0.0000135
R01SH255	1.56E-04	0.03060606	9.25E-09	0.0000205
R01SH256	2.07E-04	0.02445455	1.23E-08	0.0000273
R01SH257	2.42E-04	0.04200216	1.44E-08	0.000032
R01SH666	8.67E-05	0.29564881	5.15E-09	0.0000114
R01SH666-IN	4.51E-04	0.59262597	2.68E-08	0.0000595
R01SH666-OUT	3.62E-04	37.386215	2.15E-08	0.0033165
R02AG008	1.11E-04	20.957656	6.34E-09	0.0018239
R02AG009	4.46E-04	64.73164	2.64E-08	0.0058418
R02MG007	2.32E-04	178.75468	1.32E-08	0.016243
R02MG020	1.14E-03	51.824811	6.74E-08	0.0048216
R02MG021	4.67E-04	5.4776022	2.77E-08	0.000432
R02MG022	3.11E-04	7.6928966	1.85E-08	0.0006166
R03AG010	9.58E-05	8.2587097	5.55E-09	0.0006696
R03MG006	2.28E-04	0.36941276	1.32E-08	0.0000293
R03MG011	7.16E-05	0.68746309	4.10E-09	0.00000909
R03MG012	4.44E-05	1.1825558	2.64E-09	0.00000587
R03MG013	2.27E-04	0.73163185	1.32E-08	0.0000293
R03MG014	2.25E-04	0.68958902	1.32E-08	0.0000293
R03MG019	2.22E-04	2.3917447	1.32E-08	0.0001738
R03NC1	1.11E-04	0.46993093	6.61E-09	0.0000147
R03NC2	9.78E-05	0.451965	5.81E-09	0.0000129
R03NC3	8.89E-05	0.62083383	5.28E-09	0.0000117
R03NC4	1.04E-04	0.57538475	6.21E-09	0.0000138
R03NC5	7.33E-05	0.32694295	4.36E-09	0.00000968
R03SH158	1.44E-04	0.10931313	8.59E-09	0.0000191
R03SH159	--	0.01684416	--	--
R03SH160	3.98E-04	3.1262338	2.36E-08	0.0002903
R03SH161	1.36E-04	0.09692929	8.06E-09	0.0000179
R03SH162	1.84E-04	0.28171573	1.10E-08	0.0000243
R03SH163	9.78E-05	0.20604257	5.81E-09	0.0000129
R03SH165	1.27E-04	0.11062771	7.53E-09	0.0000167
R03SH169	2.07E-04	0.37302165	1.23E-08	0.0000273
R03SH181	2.02E-04	0.19180808	1.20E-08	0.0000267
R03SH184	1.07E-04	0.1798254	6.34E-09	0.0000141

TABLE F1-2 (Continued)

LOCATION-SPECIFIC RESULTS FOR THE SURFACE WATER TIER 1 AND TIER 2 RISK SCREENS FIVE-YEAR PERIODIC REVIEW ASSESSMENT NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

	Tier 1		Tier 2	
	Resident Scenario		Mosquito Abatement Worker Scenario	
Location ID	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
R03SH185	1.13E-04	0.13737374	6.74E-09	0.000015
R03SH186	--	23.409145	0.00E+00	0.0018705
R03SH187	--	0.17435137	--	--
R03SH189	4.76E-04	0.43965007	2.83E-08	0.0000628
R03SH270	2.11E-04	0.06846104	1.25E-08	0.0000279
R03SH273	1.20E-03	2.2459885	7.13E-08	0.0002229
R03SH274	1.38E-04	0.04694949	8.19E-09	0.0000182
R03SH275	9.33E-05	0.00713636	5.55E-09	0.0000123
R03SH276	1.04E-04	0.057	6.21E-09	0.0000138
R03SH277	1.49E-04	0.35979798	8.85E-09	0.0000196
R03SH278	--	0.02197576	--	--
R03SH279	--	0.00576364	--	--
R03SH280	1.62E-03	5.918456	9.63E-08	0.0006335
R03SH281	--	0.00385455	--	--
R03SH282	2.47E-04	0.46418543	1.47E-08	0.0000326
R03SH283	1.27E-04	0.54464646	7.53E-09	0.0000167
R03SH284	5.02E-04	0.33516306	2.99E-08	0.0000663
R03SH285	1.24E-04	0.00452727	7.40E-09	0.0000164
R03SH286	8.18E-04	1.1497403	4.86E-08	0.0001079
R03WD152	1.04E-04	0.20969625	6.21E-09	0.0000138
R03WD153	1.02E-04	0.35502002	6.08E-09	0.0000135
R03WD154	6.44E-05	0.56630932	3.83E-09	0.0000085
R03WD155	4.36E-04	0.46512266	2.59E-08	0.0000575
R03WD156	5.42E-04	1.3199603	3.22E-08	0.0000716
R03WD157	1.82E-04	0.51107187	1.08E-08	0.000024
R04MG015	2.59E-04	18.265689	1.53E-08	0.0013143
R04MG016	6.22E-05	10.663163	3.70E-09	0.0005031
R04MG017	6.89E-05	4.3994994	4.10E-09	0.0001636
R04WD195	4.02E-03	1.0843579	2.39E-07	0.0005308
R04WD199	3.93E-03	2.1596681	2.34E-07	0.0005191
R04WD200	3.22E-04	0.85686712	1.92E-08	0.0000425
R04WD203	9.20E-04	14.791855	5.47E-08	0.0013085
R04WD204	1.13E-04	0.02633896	6.74E-09	0.000015
R04WD205	5.80E-03	0.05312338	3.45E-07	0.0007654
UDRSH002	6.36E-04	0.25021212	3.78E-08	0.0000839
UDRSH006	1.42E-04	0.09469553	8.45E-09	0.0000188
UDRSH287	2.89E-04	0.20000144	1.72E-08	0.0000381

Notes

-- A risk was not calculated for this location because a residential tap water PRG was not available for the detected chemicals or the surface water concentrations did not exceed the residential tap water PRGs (Tier 2 screen).

PRG Preliminary remediation goal

ATTACHMENT F2

DEVELOPMENT OF TIER 2 RISK-BASED CONCENTRATIONS FOR SURFACE WATER

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Table

F2-1 INPUT VALUES TO DERIVE TIER 2 RISK-BASED CONCENTRATIONS

F2-2 CHEMICAL-SPECIFIC PARAMETERS AND TIER 2 RISK-BASED CONCENTRATIONS

ACRONYMS AND ABBREVIATIONS

cm	Centimeter
cm/hr	Centimeter per hour
cm^2	Square centimeter
cm^3/L	Cubic centimeter per liter
C_w	Water concentration
DAD	Dermal absorbed dose
days/year	Days per year
EPA	U.S. Environmental Protection Agency
events/day	Events per day
HI	Hazard index
hr	Hour
kg	Kilogram
µg/L	Microgram per liter
mg/cm^2-event	Milligram per square centimeter per event
mg/cm^3	Milligram per cubic centimeter
mg/kg-day	Milligram per kilogram per day
PRG	Preliminary remediation goal
RBC	Risk-based concentration

1.0 INTRODUCTION

This attachment derives equations for calculating the chemical-specific Tier 2 risk-based concentrations (RBC) for surface water. RBCs are conceptually similar to U.S. Environmental Protection Agency (EPA) Region 9 preliminary remediation goals (PRG) (EPA 2000). That is, RBCs are chemical concentrations in soil or water that correspond to a cancer risk of 1×10^{-6} or an hazard index (HI) of 1. The difference between RBCs and PRGs is that RBCs are developed using exposure parameter values for a site-specific receptor in place of the default exposure values used to develop PRGs. The soil and sediment RBCs for the Tier 2 screen were developed using the EPA Region 9 equations for a commercial/industrial worker receptor (EPA 2000). These equations are not reproduced in this attachment. The EPA Region 9 tap water PRGs (EPA 2000) do not include an evaluation of the dermal contact with water pathway, the only complete exposure pathway identified for surface water for the mosquito abatement worker evaluated in the Tier 2 screen. Accordingly, the surface water RBCs were derived using equations presented in EPA guidance for estimating dermal uptake (EPA 1992, 1998) and developing PRGs (EPA 1991).

The equations used to develop the RBCs are presented in Section 2.0. The parameters used in the RBC equations are presented in Table F2-1. The rationale for the receptor-specific exposure parameters in Table F2-1 is presented in Section 4.3 of Appendix F. The values of chemical-specific parameters and the calculated surface water RBCs are presented in Table F2-2.

2.0 CALCULATION OF RISK-BASED CONCENTRATIONS FOR SURFACE WATER

EPA guidance (1998) presents different equations for estimating dermal uptake of organic and inorganic compounds. Accordingly, the calculation of RBCs, which is a function of chemical uptake, is presented separately for organic compounds (Section 2.1) and inorganic compounds (Section 2.2).

2.1 RISK-BASED CONCENTRATIONS FOR ORGANIC COMPOUNDS

The derivation of the RBCs is based on the following standard equations used to develop PRGs for cancer and noncancer effects (EPA 1991):

$$TR = DAD \times SF_o \tag{1}$$

and

$$THI = \frac{DAD}{RfD_o} \tag{2}$$

where:

TR	=	10^{-6} (target cancer risk, unitless)
DAD	=	Dermally absorbed dose (milligram per kilogram per day [mg/kg-day])
SF_o	=	Oral cancer slope factor ([mg/kg-day]$^{-1}$)
THI	=	1 (target hazard index, unitless)
RfD_o	=	Oral reference dose (mg/kg-day)

The dermal absorbed dose (DAD) in Equations 1 and 2 was calculated using the following equations from the EPA (1998) guidance on dermal exposure assessment:

$$DAD = \frac{DA_{event} \times SA \times EV \times EF \times ED}{BW \times AT} \tag{3}$$

where:

DAD	=	Dermally absorbed dose (mg/kg-day)
DA_{event}	=	Absorbed dose per event per area of skin exposed (milligram per square centimeter per event [mg/cm^2-event])
SA	=	Skin surface available for contact (square centimeter [cm^2])
EV	=	Event frequency (events per day [events/day])
EF	=	Exposure frequency (days per year [days/year])
ED	=	Exposure duration (years)
BW	=	Body weight (kilogram [kg])
AT	=	Averaging time (days)

EPA (1998) presented two equations to estimate DA_{event}, depending on the assumed duration of the exposure event (t_{event}) and the chemical-specific lag time (τ) to reach steady state (t^*):

If $t_{event} < t^*$, then

$$DA_{event} = 2K_p C_w \sqrt{\frac{6\tau t_{event}}{\pi}} \tag{4}$$

If $t_{event} > t^*$, then

$$DA_{event} = K_p C_w \left[\frac{t_{event}}{1-B} + 2\tau \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \tag{5}$$

where:

DA_{event}	=	Absorbed dose per event per area of skin exposed (mg/cm^2-event)
K_p	=	Skin permeability coefficient for compounds in water (centimeter per hour [cm/hr])
C_w	=	Chemical concentration in water (milligram per cubic centimeter [mg/cm^3])
τ	=	Lag time (hour [hr])
t_{event}	=	Event duration (hr)
B	=	A chemical-specific constant reflecting the partitioning properties of a chemical (unitless)

Equations 4 and 5 require estimates of K_p, τ, and B. The following equations for estimating these parameters were taken from the EPA (1998) dermal guidance:

$$K_p = 10^{(-2.80-0.67\log K_{ow}-0.0056MW)} \tag{6}$$

where:

K_p	=	Permeability coefficient (cm/hr)
K_{ow}	=	Octanol-water partition coefficient (unitless)
MW	=	Molecular weight

$$B = K_P \frac{\sqrt{MW}}{2.6} \tag{7}$$

where:

B	=	A chemical-specific constant reflecting the partitioning properties of a chemical (unitless)
K_p	=	Permeability coefficient (cm/hr)
MW	=	Molecular weight

and

$$\tau = \frac{l_{sc}^{\ 2}}{6D_{sc}} \tag{8}$$

where:

τ	=	Lag time (hr)
l_{sc}	=	Apparent thickness of skin (centimeter [cm])
D_{sc}	=	Effective diffusivity for chemical transfer through the skin (cm^2/hr)

and

$$D_{sc} = l_{sc} 10^{(-2.80-0.0056MW)} \tag{9}$$

Whether to use Equation 4 or 5 for DA_{event} depends on the time to reach steady state conditions (t^*) and the exposure time (t_{event}). The time it takes to reach steady state (t^*) is evaluated as a function of B (defined in Equation 7):

If $B \leq 0.6$, then

$$t^* = 2.4\tau \tag{10}$$

If $B > 0.6$, then

$$t^* = \left(b - \sqrt{b^2 - c^2}\right)\frac{l_{sc}^{\ 2}}{D_{sc}} \tag{11}$$

where:

$$b = \frac{2(1-B)^2}{\pi} - c \tag{12}$$

and

$$c = \frac{1 + 3B + 3B^2}{3(1+B)} \tag{13}$$

Equations 1 through 5 were combined, as appropriate, and rearranged to solve for the chemical concentration in water. For the special case derived herein, where the water concentration (C_w)

corresponds to a cancer risk of 10^{-6} or a HI of 1, C_w is equal to the water RBC. The four resulting RBC equations are:

For $t_{event} < t^*$,

$$RBCc = \frac{TR \times BW \times AT_c}{SF_o \times SA \times EV \times EF \times ED \times 2K_p \sqrt{\frac{6\tau_{event}}{\pi}}} \times CF_1 \times CF_2 \tag{14}$$

and

$$RBCnc = \frac{THI \times RfD_O \times BW \times AT_{nc}}{SA \times EV \times EF \times ED \times 2K_p \sqrt{\frac{6\tau_{event}}{\pi}}} \times CF_1 \times CF_2 \tag{15}$$

For $t_{event} > t^*$,

$$RBCc = \frac{TR \times BW \times AT_c}{SF_o \times SA \times EV \times EF \times ED \times K_p \left[\frac{t_{event}}{1-B} + 2\tau \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]} \times CF_1 \times CF_2 \tag{16}$$

$$RBCnc = \frac{THI \times RfD_O \times BW \times AT_{nc}}{SA \times EV \times EF \times ED \times K_p \left[\frac{t_{event}}{1-B} + 2\tau \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]} \times CF_1 \times CF_2 \tag{17}$$

where:

RBCc	=	Cancer risk-based concentration in surface water (microgram per liter [µg/L])
TR	=	10^{-6} (target cancer risk, unitless)
BW	=	Body weight (kg)
ATc	=	Averaging time for carcinogens (days)
SF_o	=	Oral cancer slope factor ([mg/kg-day^{-1}])
SA	=	Skin surface available for contact (cm^2)
EV	=	Event frequency (events/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)

K_p	=	Permeability coefficient (cm/hr)
τ	=	Lag time (hr)
t_{event}	=	Event duration (hr)
CF_1	=	1000 (conversion factor, µg/mg)
CF_2	=	1000 (conversion factor, cubic centimeter per liter [cm^3/L])
RBCnc	=	Noncancer risk-based concentration in surface water (µg/L)
THI	=	1 (target hazard index, unitless)
ATnc	=	Averaging time for noncarcinogens (days)
RfD_o	=	Oral reference dose (mg/kg-day)
B	=	A chemical-specific constant reflecting the partitioning properties of a chemical (unitless)

2.2 RISK-BASED CONCENTRATIONS FOR INORGANIC COMPOUNDS

For either inorganic or highly ionized organic chemicals, EPA assumes that τ and B are both nearly zero. This is because the skin capacity to hold inorganic chemicals is very small and the viable epidermis will not contribute significantly as a barrier to these chemicals. Hence for inorganic chemicals,

$$DA_{event} = K_p C_w t_{event} \tag{18}$$

where:

DA_{event}	=	Absorbed dose per event per area of skin exposed (mg/cm^2-event)
K_p	=	Skin permeability coefficient for compounds in water (cm/hr)
C_w	=	Chemical concentration in water (milligram per cubic centimeter [mg/cm^3])

Combining Equation 18 with Equations 1 and 2 yields the RBC equations for inorganic compounds:

$$RBCc = \frac{TR \times BW \times AT_c}{SF_o \times SA \times EV \times EF \times ED \times K_p \times t_{event}} \tag{19}$$

$$RBCnc = \frac{THI \times RfD_O \times BW \times AT_{nc}}{SA \times EV \times EF \times ED \times K_p \times t_{event}} \tag{20}$$

where:

RBCc	=	Cancer risk-based concentration in surface water (μg/L)
TR	=	10^{-6} (target cancer risk, unitless)
BW	=	Body weight (kg)
ATc	=	Averaging time for carcinogens (days)
SF_o	=	Oral cancer slope factor ([mg/kg-day^{-1}])
SA	=	Skin surface available for contact (cm^2)
EV	=	Event frequency (events/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
K_p	=	Permeability coefficient (cm/hr)
t_{event}	=	Event duration (hr)
RBCnc	=	Noncancer risk-based concentration in surface water (μg/L)
THI	=	1 (target hazard index, unitless)
ATnc	=	Averaging time for noncarcinogens (days)
RfD_o	=	Oral reference dose (mg/kg-day)

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EPA. 1998. "Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance for Dermal Risk Assessment (Interim Guidance)." Office of Emergency and Remedial Response. NCEA-W-0364. May 7.

EPA. 2000. "EPA Region 9 Preliminary Remediation Goals (PRG)." Dated November 1. http://www.epa.gov/region09/waste/sfund/prg/

TABLE F2-1

INPUT VALUES TO DERIVE TIER 2 RISK-BASED CONCENTRATIONS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Input Parameter	Symbol	Units	Value
Molecular Weight	MW	g/mole	chemical-specific
Octanol-water Partition Coefficient	K_{ow}	unitless	chemical-specific
Skin Permeability Constant	K_p	cm/hr	chemical-specific
Stratum Corneum Thickness	l_{sc}	cm/hr	0.001
Water Contact Time	t_{event}	hr	1.00
Skin Surface Area	SA	cm^2	2,100
Event Frequency	EV	events/day	1
Exposure Frequency	EF	days/year	30
Exposure Duration	ED	years	25
Body Weight	BW	kg	70
Target Cancer Risk	TR	unitless	1×10^{-6}
Target Hazard Index	THI	unitless	1
Averaging Time (Cancer)	AT_c	days	25,550
Averaging Time (Noncancer)	AT_{nc}	days	ED x 365
Oral Cancer Slope Factor	SF_o	$(mg/kg\text{-}day)^{-1}$	chemical-specific
Oral Reference Dose	RfD_o	(mg/kg-day)	chemical-specific

TABLE F2-2

CHEMICAL-SPECIFIC PARAMETERS AND TIER 2 RISK-BASED CONCENTRATIONS
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical of Potential Concern	Molecular Weight (g/mol)	Log Kow[a]	Apparent Permeability Coefficient[a] (Kp) (cm/hr)	Oral Slope Factor[b] $(mg/kg\text{-}day)^{-1}$	Oral Reference Dose[b] (mg/kg-day)	RBC[c]	
						Cancer (µg/L)	Noncancer (µg/L)
1,1-Dichloroethane	99	1.79	--	--	1.0E-01	--	8.3E+08
Aldrin	365	3.01	--	1.7E+01	3.0E-05	5.1E+04	9.4E+06
Aluminum	26.98	--	1E-03	--	1.0E+00	--	4.1E+08
Antimony	121.76	--	1E-03	--	4.0E-04	--	1.6E+05
Arsenic	74.92	--	1E-03	1.5E+00	3.0E-04	7.6E+02	1.2E+05
Bis(2-ethylhexyl)phthalate	391	5.11	--	1.4E-02	2.0E-02	1.9E+09	1.9E+11
Cadmium	112.4	--	1E-03	--	5.0E-04	--	1.8E+05
Copper	63.55	--	1E-03	--	3.7E-02	--	1.5E+07
Dieldrin	381	4.56	--	1.6E+01	5.0E-05	6.6E+05	1.9E+08
Heptachlor	373.5	4.27	--	4.5E+00	5.0E-04	1.4E+06	1.2E+09
Iron	55.85	--	1E-03	--	3.0E-01	--	1.2E+08
Manganese	54.94	--	1E-03	--	2.4E-02	--	9.7E+06
Methylene chloride	84.9	1.25	--	7.5E-03	6.0E-02	1.2E+06	1.9E+08
Nickel	58.69	--	3E-06	--	2.0E-02	--	2.7E+09
Thallium	204.38	--	1E-03	--	6.6E-05	--	2.7E+04
Vanadium	50.94	--	1E-03	--	7.0E-03	--	2.8E+06
Zinc	65.39	--	6E-04	--	3.0E-01	--	2.0E+08

Notes:

--	Not available or not calculated.
cm/hr	Centimeter per hour
g/mol	Gram per mole
Kow	Octanol-water partition coefficient
mg/kg-day	Milligram per kilogram per day
RBC	Risk-based concentration
µg/L	Microgram per liter

a Values obtained from "Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Supplemental Guidance Dermal Risk Assessment" (U.S. Environmental Protection Agency [EPA] 1998)

b Toxicity values were obtained from the Integrated Risk Information System (EPA 2000)

c Exposure parameters for the mosquito abatement worker (see Table F2-1) were used in the risk calculations.

APPENDIX G

BASELINE ECOLOGICAL RISK ASSESSMENT
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

(264 Pages)

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G2 SUMMARY OF MEAN EFFECTS-RANGE MEDIAN QUOTIENT VALUES FOR INDIVIDUAL HABITATS CALCULATED USING SIX METALS AND MONITORING DATA FROM YEARS 1 THROUGH 5

G3 SUMMARY OF TOTAL SURFACE WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS 1 THROUGH 5

G4 DOSE CALCULATIONS FOR BIRDS AND MAMMALS

ACRONYMS AND ABBREVIATIONS

API	American Petroleum Institute
ATSDR	Agency for Toxic Substances and Disease Registry
ATSF	Atchison Topeka Santa Fe
AVS	Acid volatile sulfide
AWQC	Ambient water quality criteria
BAF	Bioaccumulation factor
BERA	Baseline ecological risk assessment
bgs	Below ground surface
BTAG	Biological Technical Advisory Group
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CNPS	California Native Plant Society
COC	Chemical of concern
COEC	Chemical of ecological concern
COPEC	Chemical of potential ecological concern
CPC	Chemical and Pigment Company
CSM	Conceptual site model
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DL	Detection limit
DOI	U.S. Department of the Interior
EC_{50}	Effects Concentration 50 percent
EFA West	Naval Facilities Engineering Command, Engineering Field Activity West
E_h	Oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
ER-L	Effects-range low
ER-M	Effects-range median
$ER\text{-}M_q$	Effects-range median quotient
GCC	General Chemical Corporation
FET	Fisher’s exact test
FS	Feasibility study
FSP	Field sampling plan

ACRONYMS AND ABBREVIATIONS (Continued)

HQ	Hazard quotient
IPCS	International Programme on Chemical Safety
kg/day	Kilogram per day
LC_{50}	Lethal concentration 50 percent
LOEC	Lowest-observable- effect concentration
µg/g	Microgram per gram
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
mg/day	Milligram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/L	Milligram per liter
mm	Millimeter
NAS	National Academy of Sciences
Navy	U.S. Department of the Navy
NOAEL	No–observed-adverse-effect level
ND	Nondetect
NWSSBD	Naval Weapons Station, Seal Beach Detachment
ORNL	Oak Ridge National Laboratory
PAH	Polynuclear aromatic hydrocarbons
PCB	Polychlorinated biphenyl
pH	Negative logarithm of the hydrogen ion concentration
ppt	Part per thousand
PRA	Probabilistic risk assessment
PRC	PRC Environmental Management, Inc.
QEA	Qualitative ecological assessment
RASS	Remedial action subsite
redox	Oxidation-reduction potential
RI	Remedial investigation
RWQCB	California Regional Water Quality Control Board
SEM	Simultaneously extracted metals
SFEI	San Francisco Estuary Institute

ACRONYMS AND ABBREVIATIONS (Continued)

SUF	Site use factor
TOC	Total organic carbon
TRV	Toxicity reference value
TtEMI	Tetra Tech EM Inc.
UCL_{95}	One-sided 95 percent upper confidence limit on the arithmetic mean
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WET	Waste extraction test
WET-DI	Waste extraction test-deionized water
WOE	Weight of evidence
WRS	Wilcoxon rank sum
XRF	X-ray fluorescence

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Engineering Field Activity West (EFA West) conducted the first postremediation five-year periodic review assessment at the four remedial action subsites (RASS) of the Litigation Area sites at Naval Weapons Station, Seal Beach Detachment (NWSSBD) Concord (Figure 1). The Navy authorized Tetra Tech EM Inc. (TtEMI), formerly PRC Environmental Management, Inc. (PRC), to conduct this review under the Comprehensive Long-term Environmental Action – Navy Contract No. N62474-94-D-7609, Contract Task Order No. 373. As part of this review, the Navy conducted a baseline ecological risk assessment (BERA), presented here as Appendix G.

During a remedial investigation (RI) for the Litigation Area in January 1986, six metals (arsenic, cadmium, copper, lead, selenium, and zinc) were identified as chemicals of concern (COC) (Lee and others 1986, 1988b). The final feasibility study (FS), submitted in September 1988, identified recommended remedial alternatives and soil cleanup criteria for each of the four sites (Cullinane and others 1988). On April 6, 1989, the Navy issued a final remedial action plan (Navy 1989a) and signed a record of decision (Navy 1989b) for the four sites.

Between 1992 and 1995, the Navy completed four remedial actions to remove contaminated soil at the Litigation Area. During the remedial actions, the most contaminated soil from each RASS was removed from active remediation areas. Because the Litigation Area includes wetlands used by several threatened and endangered species, some contaminated soil was left in place to preserve habitat.

To assess the effects and potential migration of contaminated soil left in place and to evaluate the success of the remedial actions, the Navy included a monitoring plan in its remedial design. The "Monitoring Plan for Contamination Remediation at Naval Weapons Station Concord, California" (Lee and others 1989a) was prepared for the Navy by the U.S. Army Corps of Engineers (USACE), Waterways Experiment Station. The monitoring plan has been implemented annually, with some significant modifications, for 5 years. Preremediation chemical and biological data collected in 1991 were reported in the baseline conditions report (PRC 1994). Postremediation monitoring has been conducted and reported annually since the remediation was finished (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a). Monitoring results are summarized and discussed in Appendix D.

A qualitative ecological assessment (QEA) was performed at the Litigation Area between 1995 and 1997 to evaluate whether contaminants remaining at the site after remedial actions posed a significant risk to

ecological receptors (PRC 1997b). Findings and recommendations from the QEA are summarized in Section 1.2 of this appendix.

As part of the five-year review process, a focused BERA was conducted to determine whether significant risks from contaminants remain at the Litigation Area sites. The BERA builds on and refines the results of the QEA and focuses on chemicals identified as major risk drivers in that investigation. The purpose of conducting the BERA was to determine whether remedial actions conducted to date are protective of ecological receptors or whether additional actions are necessary. The objectives of the BERA were (1) to provide information to support the five-year review assessment of whether remedial actions taken at the Litigation Area are protective of ecological receptors and (2) to provide data to help establish cleanup levels, if it is determined that additional remediation is required.

1.1 OVERVIEW OF THE ECOLOGICAL RISK ASSESSMENT PROCESS

Ecological risk assessments (ERA) are intended to fulfill the following three basic functions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):

1. Document whether actual or potential ecological risks exist at a site
2. Identify contaminants at a site that pose an ecological risk
3. Generate data to be used to evaluate cleanup options.

The U.S. Environmental Protection Agency (EPA) (1997a) separates the ERA process into the following eight steps:

Step 1: Screening-level problem formulation and evaluation of ecological effects
Step 2: Screening-level preliminary exposure estimate and risk calculation
Step 3: Baseline risk assessment problem formulation
Step 4: Study design and data quality objectives
Step 5: Field verification of sampling design
Step 6: Site investigation and analysis of exposure and effects
Step 7: Risk characterization
Step 8: Risk management

The QEA (PRC 1997b) satisfies steps 1 and 2 of this process. Additional meetings were held with the regulatory and trustee agencies to discuss the problem formulation for the BERA under step 3. Agreements reached during these meetings were incorporated in a project work plan (TtEMI 2000e) and

field sampling plan (FSP) (TtEMI 2000c) that described additional field investigations conducted during October and November 2000 (steps 4 through 6). Results from this effort were combined with data from the QEA and 5 years of postremediation monitoring and used to support the BERA discussed in this appendix. Sections 7.0 and 8.0, respectively, of this appendix characterize risk to ecological receptors (step 7) and provide recommendations to be used as part of risk management at the site (step 8).

1.2 PREVIOUS RISK ASSESSMENT WORK

The QEA performed at the Litigation Area was consistent with the guidance available at the time (EPA 1992b); however, formal clarification of the eight-step process for ERAs under CERCLA (EPA 1997a) was published after the QEA was completed. The QEA includes a complete screening-level ERA as well as components more typical of a BERA, such as bioassays. The QEA is intermediate between a screening-level and a BERA and therefore satisfies all requirements specified for steps 1 and 2 of the current eight-step ERA process, in addition to providing data for the BERA.

To evaluate risk to receptors, the QEA drew upon data collected in 1991 during the baseline monitoring and data collected in 1996 under the year 1 postremediation monitoring and QEA activities. Approaches included (1) comparison of chemical concentrations in soil, sediment, surface water, pore water, and leachate with available screening values; (2) surveys of plants and animals at the site; (3) evaluation of tissue residue in plants, invertebrates, and vertebrates; (4) toxicity tests (bioassays); (5) food-chain modeling; and (6) reviews of published literature. Twelve assessment endpoints, ranging from plants to higher-trophic-level receptors, were identified in the QEA.

Inorganic chemicals were detected frequently at concentrations exceeding screening values and were generally considered to pose the greatest risk to receptors; organic chemicals were rarely detected and were not considered to pose a significant risk. Areas identified as posing the greatest risk on the basis of chemical screening were the southeastern portion of RASSs 1 and 2, the southern reach of the main slough in RASS 1, and the Nichols Creek area in RASS 3.

The QEA concluded that plants exposed to high concentrations of some inorganic chemicals may be subject to significant risk. The small population of endangered soft bird's-beak (*Cordylanthus mollis mollis*) just northwest of the active remediation area in RASS 1 was thought to warrant special concern; however, populations of marsh and upland plants throughout most of the Litigation Area were not considered at risk from site contaminants. It was recommended that continued monitoring of special status plant populations be conducted under the long-term monitoring protocol.

Risk to aquatic invertebrates was evaluated by comparing chemical concentrations in wetland soil, sediment, surface water, pore water, and leachate with screening values derived for aquatic taxa, such as effects-range low (ER-L) and ambient water quality criteria (AWQC). On the basis of that evaluation, risk to aquatic invertebrates at the site was considered significant. Although the total concentrations of chemicals in environmental media may not be available for uptake by receptors, concentrations of chemicals in pore water and leachate samples indicated that invertebrates at the site may be exposed to toxic levels of soluble chemicals. Toxicity tests based on whole sediment (amphipod bioassays) indicated some reduction in survivorship; however, the results fell within accepted ranges when evaluated on the basis of the reference envelope approach developed by the California Regional Water Quality Control Board (RWQCB) and others (State of California Water Resources Control Board 1998).

Risk to fish at the site was evaluated by comparing concentrations in surface water and pore water with AWQC. On the basis of that evaluation, the potential adverse effects of chemicals on resident fish exposed to maximum concentrations at the site were determined to be significant. A sediment-water interface test using topsmelt (*Atherinops affinis*) embryos conducted during a subsequent monitoring event, however, indicated no effect on hatchability. Risk to migratory fish or fish that temporarily inhabit the site, such as the special status delta smelt (*Hypomesus transpacificus*) and Chinook salmon (*Oncorhynchus tshawytscha*), was considered to be low.

Risk to selected birds and mammals was evaluated by comparing estimated site-specific ingested doses of contaminants with toxicity reference values (TRV) derived through reviews of toxicological literature. Relatively conservative high and low doses were calculated using a food-chain model with different assumptions related to such parameters as body weight, ingestion rate, prey composition, and concentrations of contaminants in prey and soil. The high and low doses were compared with high and low TRVs using a hazard quotient (HQ) approach. On the basis of those evaluations, no bird or mammal was considered at significant immediate risk from any organic contaminant or most inorganic contaminants (most HQs based on low dose/high TRV were less than 1.0). In a few locations, the low dose/high TRV for the salt marsh harvest mouse exceeded 1.0 for arsenic and selenium. Risk to birds and mammals was greatest in the southeastern portion of RASS 1, west of the remediated area. Mercury at RASS 4 was evaluated further under the monitoring program to assess whether mercury exists in a bioavailable form that could affect higher-level receptors. The mercury evaluation, which was included in the fourth year monitoring report (TtEMI 1999), showed no significant risk to birds or mammals from mercury in RASS 4. Rodent tissue collected from RASS 4 contained no mercury; it was concluded that mercury was not bioaccumulating in animals at the site and does not pose a risk to higher-trophic-level birds or mammals such as the Northern Harrier (*Cirus cyaneus*) or gray fox (*Urocyon cinereoargenteus*).

1.3 REPORT ORGANIZATION

This report is organized into the following sections:

- **Section 1.0 – Introduction.** Section 1.0 provides an overview of the ERA process and a summary of previous ERA work at the Litigation Area.

- **Section 2.0 – Problem Formulation for the BERA.** Section 2.0 describes the conceptual site model (CSM), stressors, exposure pathways, critical receptors, assessment and measurement endpoints, and risk questions addressed by the BERA. The approach for conducting the BERA is also described.

- **Section 3.0 – Nature and Extent of Contamination.** Section 3.0 provides a brief discussion of the data set and the method used to identify chemicals of potential ecological concern (COPEC).

- **Section 4.0 – Exposure and Effects Assessment for Plants.** Exposure and effects to plants are assessed in Section 4.0. Section 4.1 describes the plant communities at the Litigation Area. Section 4.2 provides an evaluation of the distribution of plants and chemical contaminants in sediments and soil. Bioavailability and toxicity to plants from exposure to COPECs are assessed using tissue burdens and bioaccumulation factors (BAF) and effects-levels from literature. Soil and sediment metal concentrations are compared with Oak Ridge National Laboratory (ORNL) benchmarks for plants. Section 4.3 addresses the potential effects of COPECs on plants.

- **Section 5.0 – Exposure and Effects Assessment for Fish and Aquatic Invertebrates.** Exposure and effects on fish and aquatic invertebrates are evaluated in Section 5.0. Section 5.1 describes the fish and aquatic invertebrate communities at the Litigation Area. Section 5.2 addresses the exposure of fish and aquatic invertebrates to organic and inorganic contaminants, and results of laboratory bioassays are evaluated. Section 5.3 provides a discussion of bioavailability and bioaccumulation, and includes a summary of the literature and site-specific factors that affect bioavailability of contaminants to fish and invertebrates.

- **Section 6.0 – Exposure and Effects Assessment for Birds and Mammals.** Exposure and effects to birds and mammals are evaluated in Section 6.0. Section 6.1 describes the bird and mammal communities at the Litigation Area. Section 6.2 describes food-chain modeling, and Section 6.3 summarizes chemical doses and HQs calculated for representative birds and mammals.

- **Section 7.0 – Risk Characterization.** In Section 7.0, risk to plants, invertebrates, fish, birds, and mammals is characterized. Section 7.1 discusses the weight-of-evidence (WOE) procedure and how the process is applied to evaluate risk to assessment endpoints. Risk to plants, fish and aquatic invertebrates, and birds and mammals is characterized in Sections 7.2, 7.3, and 7.4, respectively. Section 7.5 presents ecological risk in the active remediation areas, and Section 7.6 provides a discussion of factors that introduce uncertainty into the risk assessment.

- **Section 8.0 – Conclusions and Recommendations.** In Section 8.0, the distribution of risk and chemicals of ecological concern (COEC) are summarized. Risk assessment conclusions for plants, fish and aquatic invertebrates, and birds and mammals are provided in Sections 8.1, 8.2, and 8.3, respectively.

2.0 PROBLEM FORMULATION FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT

Conclusions set forth in the QEA (PRC 1997b) and the need to better define risks for the five-year review were the basis for undertaking additional evaluation of ecological risk at the Litigation Area under step 3 of the ERA process. Step 3, or baseline risk assessment problem formulation, culminates in a scientific management decision point wherein agreement is reached among the risk assessors, the risk manager, and other involved parties with respect to four key items:

1. The assessment endpoints
2. The exposure pathways
3. The risk questions
4. A conceptual model that integrates items 1 through 3

During problem formulation for the BERA, the four items outlined previously were addressed for three broad groups of receptors: (1) plants, (2) fish and aquatic invertebrates, and (3) birds and mammals. A series of meetings between the Navy and regulatory and trustee agencies were held between December 1999 and August 2000 to address risk issues with respect to each of those receptor groups. Section 2.1 discusses the CSM for the Litigation Area, which integrates information on the assessment and measurement endpoints, chemical stressors, and exposure pathways. Section 2.2 details the BERA approach.

2.1 CONCEPTUAL SITE MODEL

The CSM is an important part of problem formulation in that it defines the exposure pathways to be evaluated in the risk assessment. It also provides other key information such as contaminant sources, release and transport mechanisms, and the relative importance of each of those processes or components to specific assessment endpoints. The CSM establishes whether a complete exposure pathway exists to a receptor of interest and aids in identifying missing information or areas of uncertainty in the understanding of how different stressors may pose a risk to selected receptors. The CSM includes the following components:

- **Stressors:** identification of site stressors in an ecological context. Stressors can be defined as any factor causing adverse ecological impacts on natural resources at the site; in this ERA, only inorganic and selected organic (total dichlorodiphenyltrichloroethane [DDT] and polychlorinated biphenyls [PCB]) chemical stressors are addressed directly. Other types of stressors are mentioned when relevant.

- **Exposure Pathways and Critical Receptors:** identification of complete ecological exposure pathways such as ingestion and the critical receptors that may be exposed. Critical receptors include representatives of important feeding guilds and special status species.

- **Fate and Transport:** description of potential pathways of chemical transport and the ultimate fate of site chemicals, including the potential for biogeochemical transformation of the chemicals, potential for on- and off-site migration of chemicals, and biotic transfer.

- **Assessment and Measurement Endpoints:** identification of assessment and measurement endpoints used to characterize risk at the site. Assessment endpoints are environmental characteristics or values that, if found to be significantly affected, would indicate a need for action by risk managers. Measurement endpoints more closely reflect technical considerations in the risk assessment process; that is, measurement endpoints are focused on more direct measures of ecological effects that allow for an evaluation of risk to assessment endpoints.

CSMs were developed in the QEA (PRC 1997b) and later refined during meetings and discussions between the Navy and regulatory and trustee agencies. The sitewide CSM provides details about exposure routes for specific assessment endpoints (Figure 16). The CSMs for each of the four RASSs incorporate information about historical and current sources and release mechanisms, receiving media, affected media, exposure pathways, and exposure mechanisms to flora and fauna (Figures 17 through 20). The following sections review components of the CSMs.

2.1.1 Chemical Stressors

The RI and FS (Lee and others 1986, 1988b; Cullinane and others 1988) focused on inorganic chemicals released to Navy property from neighboring chemical companies. Further nature and extent characterization was performed in the QEA (PRC 1997b) through the analysis of additional inorganic chemicals. Inorganic and organic COECs identified in the QEA include the following:

Inorganic COECs		Organic COECs
Arsenic	Nickel	DDT and its congeners
Beryllium	Selenium	Polynuclear aromatic hydrocarbons (PAH)
Cadmium	Silver	Chlordane
Copper	Thallium	PCBs
Lead	Vanadium	
Mercury	Zinc	

The QEA concluded that six inorganic COECs (arsenic, cadmium, copper, lead, selenium, and zinc) were the principal risk drivers at the Litigation Area; these six metals were also the focus of the remedial actions and the monitoring program. The conclusions in the QEA were based on the elevated concentrations, wide distribution, and known toxicity potential of the six metals as well as measured bioaccumulation and modeled food-chain transfer. Organic COECs were detected infrequently throughout the site and were not considered significant risk drivers.

The only known sources of organic chemicals at the Litigation Area are the former Getty Oil Nichols pump station in RASS 3 (petroleum) and the legal application of pesticides for mosquito abatement in the marsh at RASS 1. Based on a review of the existing data for DDTs and PCBs, the Navy concluded that risk from exposure to organic chemicals was adequately characterized in the QEA. To address concerns about detection limits (DL) raised by regulatory agencies, existing data for total DDTs, total PCBs, and total Aroclors were reevaluated in the BERA to determine whether the conclusions of the QEA would change if maximum reporting limits were used in the assessment instead of maximum detected concentrations.

Additional chemistry data collected in October 2000 were screened against ambient and toxicity-based benchmarks for 20 metals in sediment and surface water. COPECs evaluated in the BERA are described in Section 3.0.

2.1.2 Exposure Pathways and Critical Receptors

Receptors residing in or migrating through the Litigation Area may be exposed to site-related chemicals in sediment and soil, surface water, or prey.

Bioavailable chemicals may be accumulated in the tissues of plants and animals and can be transferred to higher trophic levels through ingestion, and some may biomagnify. Most of the Litigation Area COPECs have the potential to bioaccumulate; arsenic, mercury, and selenium may also biomagnify under certain conditions (Eisler 1988a; Saiki and Lowe 1987, as cited in Taylor and others 1992; Suedel and others 1994).

Direct and indirect effects in plants can result from uptake of chemicals from surface or subsurface soil and sediment. Protection of plant species such as pickleweed (*Salicornia virginica*) is critical for the maintenance of salt marsh harvest mouse populations. Contaminants in plants may be transferred to herbivores, including insects, rodents, and birds. If these chemicals bioaccumulate in tissues of herbivores, higher-level predators may also be exposed.

Many species ingest sediment or soil particles and detritus directly while feeding (for example, oligochaetes, filter feeders, demersal fish, and shorebirds) or indirectly while capturing sediment- or soil-covered prey (for example, wading birds, waterfowl, and raptors). Mammals and birds may incidentally ingest soil during preening, grooming, or burrowing (Beyer and others 1994).

2.1.3 Fate and Transport

Potential pathways for chemical mobilization and transport within the site and to Suisun Bay or other off-site locations include the following:

1. Groundwater-surface water interactions (groundwater recharge to surface water bodies) or direct subtidal discharge of groundwater containing dissolved chemicals into the bay
2. Surface transport, including surface water transport of dissolved chemicals or chemicals adsorbed to suspended particles, and wind transport of chemicals in soil and dust
3. Biotic transport of chemicals in plant and animal tissue from one area of the site to another or to off-site locations

These transport pathways and the potential for migration of site chemicals are discussed in the following sections; contaminant migration is also discussed in detail in Appendix E. A schematic diagram of exposure routes and potential receptors at the Litigation Area are provided in the CSMs for the site (Figure 16) and for each of the RASSs (Figures 17 through 20).

2.1.3.1 Groundwater-Surface Water Interactions

Most of the metals in surface water and groundwater at the Litigation Area are not in the dissolved state but are associated with suspended particles. Chemicals associated with suspended particles are not readily exchanged between groundwater and surface water; therefore, groundwater to surface water is not considered an important transport pathway either into or out of aquatic habitats throughout most of the Litigation Area. Moreover, groundwater flow rates in the Litigation Area marsh are extremely slow (on the order of a few feet per year); therefore, groundwater discharge to Suisun Bay is assumed to be negligible (Appendix E). However, one area of uncertainty relating to potential groundwater-surface water interactions in Nichols Creek is present near the Chemical and Pigment Company (CPC) border. Historical data show high concentrations of zinc in groundwater samples collected from wells in the center and at the northwestern corner of the CPC, and evidence indicates that a perched zone may exit in this area, allowing groundwater to flow into Nichols Creek (Appendix E). At a risk management meeting held with the regulatory agencies on March 27, 2002, the Navy proposed conducting limited additional sampling near the border between CPC and Navy property to further investigate this potential pathway.

Additional discussion of the proposed sampling effort is provided in Section 10.0 of the five-year review report.

2.1.3.2 Surface Transport Pathways

The main mechanism of surface transport of chemicals at the Litigation Area is surface water transport of suspended sediments containing adsorbed chemicals. Dissolved chemicals in surface water are considered secondary to transport through suspended particulates. Tidal exchange and overland flow of surface runoff are the main routes of potential migration of site chemicals to Suisun Bay. Wind transport of contaminated soil is potentially important in the more arid upland habitats of the site during the driest months of the year. The dense cover of matted vegetation over the marsh surface and in riparian areas precludes wind transport as an important pathway elsewhere at the site.

Surface water bodies at the Litigation Area include the natural slough (referred to as Lost Slough) and tributaries that meander throughout the marsh, the network of mosquito abatement ditches, a ponded area at the west end of RASS 3, and Nichols Creek which drains into the pond and discharge to the wetlands at low tide. RASS 1 is a flat marsh incised by a natural slough, tributaries, and an extensive network of mosquito abatement ditches. The RASS 3 pond is hydraulically connected to RASS 1; both are tidally influenced. The base of the RASS 3 pond is elevated relative to the slough and ditches, but a submerged embankment prevents complete drainage of the pond.

The semidiurnal tides in Suisun Bay cause the slough and mosquito abatement ditches in the Litigation Area to flood and partially drain twice daily, although ditches and sloughs normally retain some water. Both seaward and landward currents in the ditches and slough are strong, with intervening periods of slack water. The tides are regularly high enough to flood the marsh surface. Water flowing across the marsh surface can potentially entrain and mobilize sediments to and from the marsh surface, causing transport of sediments both into and out of the ditches and Lost Slough.

Nichols Creek, a narrow, seasonal creek, drains a small, undeveloped upland watershed of approximately 1 square mile in the Los Medanos Hills, south of the site (Cullinane and others 1988). The creek currently runs along the western boundary of the property of the CPC, through a culvert beneath the southern set of railroad tracks, along the south side of the northern railroad tracks to the RASS 3 pond (Figure 1). The creek discharges to the pond and subsequently to the marsh by flowing beneath the railroad trestle at the northwest corner of RASS 3. The creek is narrow (3 to 5 feet wide) and shallow (1 to 2 feet deep), and the creek bed is completely dry during the dry season (typically April through October).

Chemicals adsorbed to soil particles can be borne by wind, which blows primarily from the west-northwest through Carquinez Strait; as a result, airborne particles may be moved primarily to the east-southeast. The potential movement of chemicals as airborne particles is not considered to be a significant transport process in permanently wet habitats; however, wind may transport particulates during annual dry periods.

2.1.3.3 Biotic Transport

Chemicals may also be transported in plant and animal tissues. Chemicals in the tissue of mobile receptors such as some fish, migrating birds, flying insects, and other far-ranging predators, may be carried off site and deposited in other locations in the form of feces or corpses. In addition, distribution and partitioning of chemicals are affected by the activities of burrowing animals such as amphipods and fish in wetland environments (Greene and Chandler 1994).

2.1.4 Assessment and Measurement Endpoints

By definition, assessment endpoints have ecological, toxicological, and societal importance (EPA 1992b). Site-specific factors influenced the selection of endpoints, including the occurrence, ecological significance, conservation status, life and natural history characteristics, and potential toxicological susceptibility of receptors; the known and potential contaminants present and their mechanisms of toxicity; and the spatial and temporal patterns of potential exposure. Measurement endpoints are considered to be primary lines of evidence that have a direct relationship to the assessment endpoints defined for each receptor group.

Discussions between the Navy and the regulatory and trustee agencies were held during problem formulation to reach agreement on risk questions and assessment and measurement endpoints. Twelve assessment endpoints, ranging from plants to higher-trophic-level receptors, were identified for specific evaluation during the QEA (PRC 1997b). Similar endpoints were chosen for the BERA to represent risk posed through all major exposure pathways at this site. Risk questions and assessment and measurement endpoints for plants, fish and aquatic invertebrates, and birds and mammals are discussed in the following sections.

2.1.4.1 Plants

The QEA (PRC 1997b) concluded that the risk to plants was not significant except in areas of the highest concentrations of certain metals in soil or sediment. No visible impacts in the form of large areas of dead

or dying vegetation have been observed across the site, even in areas with the highest concentrations of metals.

A summary of assessment and measurement endpoints and risk questions for plants is provided in Table 46. Table 47 lists the hypotheses tested as part of this evaluation. Components added to the BERA to extend analyses conducted in the QEA included comparison of existing data with ORNL soil benchmarks and a review and additional analysis of data on plant communities. The additional analysis included evaluation of trends between plant community metrics (mean height and percent cover) and metals along a gradient of metal concentrations in soil and sediment.

Assessment Endpoints

The assessment endpoints for plants are the same endpoints used in the QEA: (1) sufficient rates of survival, growth, and germination to sustain populations of upland plants and (2) sufficient rates of survival, growth, and germination to sustain populations of wetland plants.

Measurement Endpoints

The measurement endpoints for plants are (1) concentrations of contaminants in soil and sediment, (2) concentrations of contaminants in plant tissue, and (3) plant community measures (percent cover and mean plant height).

Risk Questions

The risk questions addressed for upland and wetland plants were as follows:

- Are concentrations of COCs in upland soils above the ORNL plant benchmarks or other effects levels reported in the literature?
- Are plants bioaccumulating contaminants at levels that may pose a risk to survival, growth, and reproduction?
- Do indicators of native plant assemblages, such as percent cover and mean height, show a trend with respect to sitewide concentrations of metals?

2.1.4.2 Aquatic Invertebrates and Fish

Data gaps in the assessment of risk to fish and aquatic invertebrates identified during baseline problem formulation included the following:

- Amphipod (*Eohaustorius estuarius*) bioassays performed for the QEA (PRC 1997b) did not include sediments collected from the most contaminated areas of the site.
- Only one invertebrate species was tested.
- Data were insufficient to support assessment of potential toxicity in surface water at the Litigation Area.
- Additional clam tissue samples were needed to provide better characterization of tissue levels of metals to support the calculation of BAFs and food-chain modeling to higher-order receptors.

Each of these data gaps was addressed in a draft final work plan prepared to support the additional field work conducted during October 2000 (TtEMI 2000e). The first data gap was addressed by proposing the use of field X-ray fluorescence (XRF) as a range-finding technique to focus sediment collection at areas of the site with the highest metal concentrations. The second data gap was addressed by the addition of a second whole-sediment bioassay (*Hyalella azteca* 14-day) to add an additional test endpoint (growth) and provide a means to better account for interspecific variability in sensitivity to inorganic contaminants. The third data gap was addressed in the draft final work plan; the draft final work plan included a 96-hour surface water bioassay using *Neomysis mercedis* as an additional measurement endpoint to address the surface water data gap. Field collection efforts conducted at Lake Merced, San Francisco Bay, and Tomales Bay in early October failed to capture sufficient numbers of gravid females to successfully run the test. It was concluded that the test could not be conducted during the 2000 field season; therefore, the evaluation of surface water in the BERA was based only on a comparison of site chemistry with the water quality benchmarks. The fourth data gap was addressed by the proposal to collect additional clam samples as part of the October 2000 field effort. Locations sampled in the field investigation in October 2000 are shown on Figure 14.

Assessment and measurement endpoints and risk questions addressed for fish and aquatic invertebrates are summarized in Table 48. Table 49 lists the hypotheses tested as part of this evaluation.

Assessment Endpoints

The assessment endpoints for aquatic invertebrates and fish are the same endpoints used in the QEA: (1) sufficient rates of survival, growth, and reproduction to sustain populations of aquatic invertebrates and (2) sufficient rates of survival, growth, and reproduction to sustain populations of fish.

Measurement Endpoints

The measurement endpoints for aquatic invertebrates and fish are as follows:

- Concentrations of contaminants in Litigation Area surface water
- Concentrations of contaminants in sediments
- Concentrations of contaminants in clam, amphipod, crayfish, tadpoles, damselfly nymphs, and fish tissue
- Measures of survival from 10-day whole-sediment toxicity tests using the amphipod *Eohaustorius estuarius*
- Measures of survival and growth from 14-day whole-sediment toxicity tests using the amphipod *Hyalella azteca*
- Measures of percent hatch from 12-day sediment-water interface toxicity tests using the topsmelt (*Atherinops affinis*)

Additional lines of evidence used in the assessment and interpretation of measurement endpoints include (1) calculation of simultaneously extracted metals (SEM) and acid volatile sulfides (AVS) for sediments, (2) concentrations of contaminants in sediment pore water, and (3) concentrations of contaminants in sediment extracts (from waste extraction tests [WET]).

The draft final work plan (TtEMI 2000e) included an evaluation of benthic community measures as an additional line of evidence. The rationale for subsequent exclusion of benthic community data analysis in the BERA is provided in Section 5.0.

Risk Questions

The risk questions addressed for aquatic invertebrates and fish included the following:

- Do contaminants in surface water at the Litigation Area exceed water quality benchmarks?
- Do contaminants in sediments exceed the effects-range median (ER-M) (and thresholds based on effects range-median quotient [ER-M_q])?
- Are fish and aquatic invertebrates bioaccumulating contaminants at levels that pose a risk to survival, growth, and reproduction?
- Is survival of *Eohaustorius estuarius* at contaminated sites less than the RWQCB reference envelope edge?

- Are survival and growth of *Hyalella azteca* at contaminated sites less than survival and growth in laboratory controls?
- Is percent hatch of the topsmelt at contaminated sites less than the percent hatch in laboratory controls?

2.1.4.3 Birds and Mammals

Dose estimates in the QEA (PRC 1997b) were based on very conservative assumptions for food-chain model parameters. It is unknown whether the dose estimates reflect true risk to populations or are merely an artifact of the model assumptions. Additionally, it was concluded during problem formulation that analysis of existing data for the salt marsh harvest mouse was not sufficient to address questions of risk to individuals. To address these issues, the Navy recalculated the dose estimates using more realistic exposure parameters. The Navy also proposed the use of probabilistic risk assessment (PRA) as an additional approach for the salt marsh harvest mouse if initial food-chain modeling results suggested it would aid decision making.

Assessment and measurement endpoints and risk questions for birds and mammals are summarized in Table 50. Table 51 lists the hypotheses tested as part of this evaluation. A list of special status species known or expected to occur at the Litigation Area is provided in Table 11. Species with threatened or endangered status known or expected to occur at the Litigation Area are listed in Table 12.

Assessment Endpoints

The assessment endpoints for birds and mammals are the same endpoints used in the QEA. For each of the eight trophic guilds selected as assessment endpoints, a representative or surrogate species was identified on the basis of information available in bird and mammal surveys and natural history assessments conducted at the site. The endpoints are sufficient rates of survival, growth, and reproduction to sustain populations of species representing the following trophic guilds:

- Aquatic avian omnivores (as represented by the Mallard, *Anan platyrhynchos*)
- Carnivorous shorebirds (as represented by the California Black Rail, *Laterallus jamaicensis coturniculus*)
- Omnivorous passerines (as represented by the Suisun Song Sparrow, *Melospisa melodia maxillaries*)
- Raptors (as represented by the Northern Harrier, *Circus cyaneus*)

- Wading birds (as represented by the Great Blue Heron, *Ardea herodias*)
- Herbivorous mammals (as represented by the salt marsh harvest mouse *Reithrodontomys raviventris*)
- Aquatic carnivorous mammals (as represented by the river otter, *Lutra canadensis*)
- Terrestrial carnivorous mammals (as represented by the gray fox, *Urocyon cinereoargenteus*)

For special status species (California Black Rail and salt marsh harvest mouse), protection of individuals is an additional assessment endpoint.

Measurement Endpoints

The measurement endpoints are daily-ingested chemical doses and HQs calculated for each species using food-chain modeling.

Risk Questions

The risk question addressed for each endpoint is: Do typical site-specific ingested doses of chemical contaminants exceed effects levels defined by the low and high TRVs?

2.2 ECOLOGICAL RISK ASSESSMENT APPROACH

This section describes the rationale and overall approach for the BERA, which used existing information from the QEA (PRC 1997b) and postremediation monitoring studies in addition to data collected in October 2000 to fill the data gaps identified during baseline problem formulation. The BERA focused on lines of evidence within three primary assessment categories: (1) toxicity, (2) bioaccumulation, and (3) bulk chemistry, which were integrated during risk characterization using a WOE approach.

Because the QEA focused almost exclusively on inorganic chemicals known to have been released by neighboring landowners, the regulatory agencies requested that the Navy include a screening-level evaluation of total DDTs, total PCBs, and total Aroclors as part of the BERA.

2.2.1 Screening-level Ecological Risk Assessment for Organic Chemicals

The screening-level ERA of organic chemicals addressed regulatory agency concerns about the high frequency of concentrations reported as below the DL, also known as nondetect (ND) data. The evaluation of organic contaminants at the Litigation Area included reanalysis of data presented in the QEA (PRC 1997b). At a meeting on August 8, 2000, the Navy and the regulatory and trustee agencies

agreed to focus the evaluation of organic compounds on PCBs and DDTs in sediments and soils. These compounds were selected based on the frequency with which individual organic contaminants exceeded ER-L and ER-M sediment benchmarks. The evaluation of existing data on organic contaminants included three components:

1. A sensitivity analysis to determine the effect of estimating chemical concentrations based on substituting one-half the DL or the full DL for all ND data

2. Evaluation of a worst-case scenario, in which maximum chemical concentrations using the higher of the detected concentrations or the full DL for ND data were used in all analyses

3. A spatial analysis to determine the sampling locations with detected concentrations of total DDTs and PCBs (or Aroclors) that have the highest worst-case concentrations of total DDTs or Aroclors and relatively low risk from metals

Details of the reevaluation of organic contaminants and the assessment of risk to fish and aquatic invertebrates and birds and mammals, respectively, are provided in Sections 5.0 and 6.0.

2.2.2 Baseline Ecological Risk Assessment for Inorganic Chemicals

The BERA for inorganic chemicals included data from three sources: (1) the QEA (PRC 1997b), (2) 5 years of postremediation monitoring, and (3) samples collected in October 2000 for the BERA. The approach for evaluating plants, fish and aquatic invertebrates, and birds and mammals is discussed in the following sections.

2.2.2.1 Approach for Evaluating Risk to Plants

Data for evaluating risk to plants in the BERA include the following:

- Concentrations of metals in plant tissue collected from 85 locations in 1991 and 1995 from the QEA (PRC 1997b)

- Concentrations of metals and organic contaminants in soils and sediments from the QEA and postremediation monitoring studies

- Concentrations of metals in leachate (WET-acid, WET-deionized water [WET-DI]) from 59 soil and sediment samples from the QEA

- Vegetation characterization and special status plant surveys conducted during the QEA and postremediation monitoring

Toxicity to wetland and upland plants was evaluated by (1) comparing soil concentrations of metals with ORNL benchmarks (Efroymson and others 1997); (2) comparing tissue concentration data with effects levels published since the QEA; and (3) correlating indicators, such as percent cover and mean height, with sitewide concentrations of metals. The ORNL soil benchmarks for plants are provided in Table 52.

2.2.2.2 Approach for Evaluating Risk to Aquatic Invertebrates and Fish

Data from the QEA (PRC 1997b) and monitoring program for evaluating risk to aquatic invertebrates and fish include the following:

- Concentrations of metals, PCBs, and DDTs in surface water from the QEA and postremediation monitoring (metals only) studies
- Concentrations of metals, PCBs, and DDTs in sediments from the QEA and postremediation monitoring (metals only) studies
- Concentrations of metals, PCBs, and DDTs in pore water from the QEA and postremediation monitoring (metals only) studies
- Concentrations of metals, PCBs, DDTs in fish (four samples), clams (three samples), amphipod (three samples), crayfish (one sample), tadpoles (one sample), and damselfly nymph (one sample) from the QEA
- Ten-day whole-sediment *Eohaustorius estuarius* bioassays at 23 sampling locations conducted during the QEA
- Twelve-day sediment-water interface bioassays using the topsmelt at 10 locations conducted during the year 4 monitoring

Data collected in October 2000 to support the baseline evaluation of risk to invertebrates and fish included collocated samples for chemical analysis and toxicity testing, as follows:

- Ten-day whole-sediment *Eohaustorius estuarius* bioassays at seven locations with high metal concentrations
- Ten-day whole-sediment *Hyalella azteca* bioassays at 13 locations (10 site and 3 reference locations) that represent a range of low to high metal concentrations
- Analysis of Contract Laboratory Program (CLP) metals in clam tissue from seven locations with high metal concentrations also used for amphipod bioassays
- Analysis of sediments from all locations selected for additional amphipod bioassays for CLP metals, grain size, total organic carbon (TOC), ammonia, negative logarithm of hydrogen ion concentration (pH), and sulfides

- Analysis of surface water from four locations for hardness, salinity, pH, total dissolved solids, total suspended solids, and TOC
- Analysis of SEM-AVS at the seven locations selected for additional *Eohaustorius estuarius* bioassays

The toxic potential of contaminants was addressed by (1) reviewing the literature on mechanisms of toxic action for the six metal COECs; (2) directly measuring toxicity through bioassays; (3) comparing site chemistry data with toxicity benchmarks established for water and sediments; and (4) measuring chemical concentrations in fish, clam, amphipod, crayfish, tadpole, and damselfly nymph tissue. Inorganic and organic acute and chronic AWQC and sediment screening benchmarks for assessing risk to fish and aquatic invertebrates are provided in Tables 10A, 10B, and 53, respectively.

2.2.2.3 Approach for Evaluating Risk to Birds and Mammals

Available data for evaluating risk to birds and mammals include the following:

- Concentrations of metals, PCBs, and DDTs in sediments from the QEA (PRC 1997b) and postremediation monitoring (metals only) studies
- Concentrations of metals and organic contaminants in plants (many samples), fish (four samples), clams (three samples), amphipods (three samples), crayfish (one sample), tadpoles (one sample), and damselfly nymphs (one sample) from the QEA
- Wildlife and avian characterization studies conducted during preremediation and annual postremediation monitoring surveys
- Natural history summaries for representative birds and mammals

Existing data were augmented by the analysis of CLP metals in clam tissue from seven locations selected for whole-sediment amphipod bioassays in Units 10 and 11 and the proposed slough reference area in October 2000.

Food-chain models were used to assess the exposure of birds and mammals to ingested contaminants. Food-chain models are one method of integrating ecological and chemical information into the risk assessment process, especially for contaminants that tend to bioconcentrate or bioaccumulate (Pascoe and others 1996). Results of screening-level food-chain modeling, using conservative assumptions and values for model parameters, for six avian (California Black Rail, Suisun Song Sparrow, Mallard Duck, Great Blue Heron, American Kestrel, and Northern Harrier) and four mammalian (salt marsh harvest mouse, gray fox, river otter, and California vole) assessment endpoints, conducted as part of the QEA, were used to refine the models.

Exposure units were defined for each bird and mammal receptor based on estimates of the within-site home ranges of each receptor. The mean concentration of a metal in soil and sediment within each exposure unit was used as the exposure point concentration (EPC) in food-chain models. Estimated chemical doses and HQs based on high and low TRVs were calculated for each metal and for all receptors, using the appropriate exposure unit for each receptor. The food-chain modeling emphasized the six metals previously identified in the QEA.

2.2.3 Weight-of-Evidence Approach

Results for each of the lines of evidence in the risk assessment were evaluated using a WOE approach. A WOE approach is one tool that has been proposed for evaluating multiple lines of evidence in the ERA process (Menzie and others 1996). The main objectives of the risk characterization process were to identify (1) receptors at immediate or potential risk and (2) spatial areas where EPCs may pose the greatest risk. The WOE process provides a way to efficiently organize multiple, and sometimes conflicting, lines of evidence in a manner that supports decision-making.

The WOE approach used a qualitative evaluation of the lines of evidence and best professional judgment to aid in the interpretation of results. The WOE approach was applied at a spatial scale appropriate to the receptor group being evaluated. For example, risk to the salt marsh harvest mouse was evaluated on a small spatial scale (an individual sampling location), but risk to more mobile receptors was evaluated on larger scales (pooled sampling locations, spatial units, or RASSs). Table 54 summarizes the decision criteria used in the interpretation of results for each line of evidence. Table 54 reflects agreements reached by the Navy and regulatory and trustee agencies during development of the draft final work plan (TtEMI 2000e). Additional details of the WOE process and its application in the BERA are provided in Section 7.0. Conclusions reached following the application of the WOE process are presented in Section 8.0.

3.0 NATURE AND EXTENT OF CONTAMINATION

This section identifies and describes the extent of contamination for COPECs evaluated in the BERA at the Litigation Area. The chemistry data that support the BERA are summarized below:

- **QEA (PRC 1997b):** Figure 13 shows locations sampled for organic chemicals in 1996 under the QEA. Organic chemicals were analyzed in surface soil and sediment samples (0 to 0.5 foot below ground surface [bgs]) and a subset of subsurface soil and sediment samples (1.0 to 1.5 feet bgs). Semivolatile organic compounds, PCBs or Aroclors, and pesticides in soil and sediment were analyzed at all locations. Total petroleum hydrocarbons were analyzed in samples from areas near or downstream from the former Getty Oil pump

station in RASS 3. Volatile organic compounds were analyzed at seven locations in RASS 3 near the former Getty Oil pump facility. Organotins were measured in sediment from the main slough near Suisun Bay. CLP methods were used at most locations (PRC 1997b); low-level detection methods were used for a subset of samples from the upland and marsh reference areas (PRC 1997b). Organic chemicals were also analyzed in pore water and surface water samples, but were rarely detected; those data are not discussed further in the BERA. Complete results are presented only for organic chemicals identified as COPECs (Section 3.1).

Inorganic data collected in 1996 under the QEA for the six metals in soil, sediment, and surface water were combined with the year 1 monitoring data and are discussed with the monitoring data. Data for other inorganic chemicals were evaluated in the QEA but are not included in the BERA.

- **Years 1 through 5 Monitoring Data:** Figure 12 shows the locations sampled in the annual monitoring program. The six metals (and mercury in RASS 4) were analyzed in surface soil and sediment (0 to 0.5 foot bgs) and surface water samples in year 1 (PRC 1996b), year 2 (PRC 1997a), year 3 (TtEMI 1998), year 4 (TtEMI 1999), and year 5 (TtEMI 2000a) of the monitoring program. Complete results are presented in Section 3.1.

- **New data Collected in October 2000**: Figure 14 shows the locations sampled for inorganic chemicals in surface soil and sediment (0 to 0.5 foot bgs) and surface water in October 2000 to support the BERA. The FSP provides details on this sampling (TtEMI 2000c). A summary of the data and results is presented in the following text.

3.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

The QEA (PRC 1997b) identified 12 inorganic and 4 organic chemicals as preliminary COCs (see the table presented in Section 2.0).

Conservative assumptions in the screening-level ERA (or QEA in this case) typically lead to the identification of some COPECs that may actually pose negligible risk; the purpose of the BERA is to refine the list of COPECs based on more realistic exposure assumptions and eliminate those that pose negligible risk from further consideration (EPA 1997a). COPECs identified in the QEA were further evaluated and discussed with the regulatory and trustee agencies during problem formulation meetings. Meeting attendees determined which of these chemicals warranted further evaluation as COPECs in the BERA and which would be dropped from further consideration because of negligible risk.

3.1.1 Organic Chemicals

Organic chemicals were detected infrequently across the site and were not identified as significant risk drivers in the QEA (PRC 1997b). As described in the work plan (TtEMI 2000e) and meeting minutes from August 8, 2000 (TtEMI 2000b), only total DDTs, total PCBs, and total Aroclors were determined to

warrant additional assessment in the BERA. Based on discussions with regulatory and trustee agencies, other organic COPECs (chlordane and PAHs) were eliminated from further discussion because of low detection frequency and magnitude.

The relatively high DLs shown in the CLP analysis of DDTs and Aroclors caused concern that risk characterization would be associated with a high degree of uncertainty. The Navy's reevaluation of existing data on total DDTs and total PCBs and Aroclors included the following three components:

1. A sensitivity analysis to determine the effect of estimating chemical concentrations based on substituting one-half the DL or the full DL for ND data

2. An evaluation of a worst-case scenario under which maximum chemical concentrations using the higher of the detected concentrations or the full DL for ND data were used in all analyses

3. A spatial analysis to determine the sampling locations with detected concentrations of total DDTs and PCBs (or Aroclors) that have highest worst-case concentrations of total DDTs or Aroclors and relatively low risk from metals

Fish and aquatic invertebrates were evaluated separately from birds and mammals in the BERA using appropriate exposure scenarios for each group. Additional details and full discussion of the results of the reevaluation of organic contaminants are presented in Sections 5.0 and 6.0.

3.1.2 Inorganic Chemicals

The identification of inorganic COPECs for the BERA was based on conclusions from the QEA and subsequent discussions with the regulatory and trustee agencies as well as chemistry results from the October 2000 sampling event.

3.1.2.1 Conclusions from the Qualitative Ecological Assessment

The QEA (PRC 1997b) concluded and the regulatory and trustee agencies agreed that six preliminary inorganic COECs (arsenic, cadmium, copper, lead, selenium, and zinc) were the principal risk drivers at the Litigation Area. This determination was made based on the elevated concentrations, wide distribution, known toxicity potential, measured bioaccumulation, and results of food-chain modeling.

Mercury was of concern only in RASS 4, so a special study conducted during the year 4 monitoring (TtEMI 1999) focused on food-chain modeling to evaluate risk to higher-level receptors. Results of the study indicated negligible risk to higher-level receptors.

3.1.2.2 Chemistry Results from the October 2000 Sampling Event

Sediment and surface water samples collected in October 2000 were screened against ambient and toxicological benchmarks to determine whether additional inorganic COPECs should be identified. Results are presented below.

Screen of Sediment Samples

Table 55 provides a summary of the screen conducted for 20 metals analyzed at 14 locations from the main slough, slough reference area, and RASS 1 ditches. Chemistry samples were collocated with sediment collected for the *Eohaustorius* and *Hyalella* bioassays discussed in Section 5.0. Slough and ditch locations were combined for the screening step; slough reference locations are considered separately (Table 55).

The following two tiers of analysis were conducted as part of the screen:

1. Comparison of site sediment chemical concentrations with ambient concentrations for 19 metals at the Concord Tidal Area (PRC 1996a) and 10 metals for San Francisco Bay (RWQCB 1998b)

2. A toxicity evaluation wherein site chemical concentration were compared with 11 ER-Ls and ER-Ms for inorganic chemicals

The types of analyses performed in the screen depended on the sample sizes for each of the areas evaluated and the detection frequencies for each chemical. Descriptions of all analyses under each tier and summaries of the results are presented below.

<u>Comparisons to Tidal Area Ambient Sediment Concentrations</u>

For sample sizes greater than 10 and detection frequencies greater than or equal to 50 percent, the nonparametric, two-population Wilcoxon rank sum (WRS) test was used to compare median concentrations of chemicals at the site with Tidal Area ambient concentrations. For sample sizes greater than 10 but detection frequencies less than 50 percent in either the site or ambient population, Fisher's exact test (FET) was used to compare the proportion of detected samples in the two populations. For cases in which the site median was less than or equal to the median concentration in the ambient data set based on the WRS test, the quantile test was used to test for differences in the right-hand tail concentrations of the two populations (Navy 2000). The quantile test was also used following all comparisons made using the FET. For sample sizes less than 10, the maximum chemical concentration from the site was compared with the 99th percentile of the Tidal Area ambient population. The ambient

threshold previously reported was the 95th percentile of the ambient population (PRC 1996a). However, the ambient threshold was established as the 99th percentile for this review based on a recommendation by DTSC.

Median chemical concentrations in the slough and ditches exceeded median concentrations in the Tidal Area ambient population for 11 of 12 metals compared using the WRS test: aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc (Table 55). The proportion of detected samples from the slough and ditches exceeded the proportion of samples detected in the Tidal Area ambient population for the following three of seven metals compared using the FET: beryllium, cadmium, and selenium. The following three out of eight metals in the slough and ditches exceeded the Tidal Area ambient concentrations based on the quantile test: beryllium, cadmium, and mercury. The following 5 out of 16 metals in the slough reference area exceeded Tidal Area ambient concentrations based on comparison of the maximum site concentration with the 99th percentile of the Tidal Area ambient distribution: aluminum, beryllium, chromium, nickel, and vanadium (Table 55).

Comparisons to San Francisco Bay Ambient Sediment Concentrations

Site concentrations were compared with San Francisco Bay ambient concentrations as follows:

- For sample sizes greater than or equal to 10, the one-sided 95 percent upper confidence limit of the arithmetic mean (UCL_{95}) for the site concentration was compared with the 85th percentile of the San Francisco Bay ambient distribution for less than 100 percent fines (RWQCB 1998b) (Table 3 of Volume II).

- For sample sizes less than 10, the maximum site concentration was compared with the 85th percentile of the San Francisco Bay ambient for less than 100 percent fines.

Concentrations of 7 out of 10 metals in the slough and ditches exceeded the San Francisco Bay ambient concentrations: arsenic, cadmium, copper, lead, selenium, silver, and zinc. Concentrations of the following six metals in the slough reference area exceeded the San Francisco Bay ambient concentrations: arsenic, cadmium, copper, lead, nickel, and zinc.

Toxicity Evaluation for Sediment

Site sediment concentrations were compared with ER-Ls and ER-Ms in two ways: (1) for both the combined slough and ditch locations and slough reference area, the number of locations in each area that exceeded the ER-L or ER-M, and (2) for the combined slough and ditch locations only, the UCL_{95} was compared with the ER-L and ER-M (Table 55).

Samples from at least 1 of the 11 slough and ditch locations exceeded each of the ER-L benchmarks. All 11 slough and ditch locations exceeded the ER-L for arsenic, cadmium, copper, nickel, and zinc. The ER-M was exceeded for the following six metals (the number of locations exceeding the ER-M is shown in parentheses after each metal): arsenic (6), cadmium (7), copper (3), nickel (10), selenium (4), and zinc (11). The UCL_{95} for the combined slough and ditch locations exceeded the ER-M for the following six metals: arsenic, cadmium, copper, nickel, selenium, and zinc.

For the slough reference area, two out of three locations exceeded the ER-L for chromium, and all three locations exceeded the ER-Ls for arsenic, copper, mercury, nickel, and zinc. All three slough reference area locations had sediment concentrations that exceeded the ER-M for nickel. Concentrations of the other 10 metals were all less than the ER-M at each of the slough reference area locations.

Summary and Conclusions of the Sediment Screen

The screen of 20 metals collected at 14 locations in October 2000 supports previous findings that concentrations of arsenic, cadmium, copper, lead, selenium, and zinc are elevated in slough and ditch sediment. This finding is not surprising since sampling was focused in areas that historically have shown high metal concentrations. Field XRF methods were used as a range-finding technique to ensure that the most contaminated locations from the ditch and slough were selected for analysis. Results from this latest screening of Litigation Area sediment lend additional support to conclusions from the QEA (PRC 1997b) that these six metals are the most likely risk drivers at the site. A graphical summary of the results for the six metals is provided on Figure 75. Metal concentrations on Figure 75 were compared with ER-Ls and ER-Ms and the grand mean concentrations for the 5 years of monitoring in those habitats. Results for other sediment parameters are presented in Table 56 and discussed in Section 5.0.

The ER-M for nickel was exceeded at 10 of 11 ditch and slough locations, and the UCL_{95} for nickel in the slough and ditches was also greater than the ER-M. The UCL_{95} for nickel (80.8 milligrams per kilogram [mg/kg]) was, however, less than both the 99th percentile ambient concentration for the Tidal Area data set (120 mg/kg) and the 85th percentile for San Francisco Bay (112 mg/kg). Nickel concentrations in general are relatively high in Bay Area sediment (RWQCB 1998b); therefore, nickel is not considered a COPEC in the BERA. No metals outside of the core group of six metals already considered as COCs warrant further consideration based solely on comparison with the ER-M.

Aluminum and manganese are the only metals for which UCL_{95} concentrations exceed Tidal Area ambient concentrations to any degree, although maximum concentrations of these metals only exceed ambient concentrations by a factor of 1.4 for aluminum and 4.1 for manganese. No ER-Ls or ER-Ms are

available for aluminum or manganese. Manganese was not considered a COPEC in the BERA and was not evaluated further. Aluminum concentrations in sediment raise concern, as high concentrations of total aluminum were detected in the October 2000 surface water samples, and aluminum has been identified as a contaminant of concern at General Chemical Corporation (GCC) (Appendix E). During a site inspection tour on July 27, 2001, the Navy and the regulatory agencies observed a railcar leaking white powder onto the Atchison Topeka Santa Fe (ATSF) Railroad tracks. In addition, RWQCB observed the railcar leaking between July and September 2001. RWQCB collected and submitted a sample of the powder to Sequoia Analytical Laboratory in Petaluma, California, for chemical analysis. The powder consisted of approximately 13-percent aluminum by weight (130 g/kg), with lesser amounts of beryllium (1.1 mg/kg) and zinc (41 mg/kg). The aluminum-based powder was initially believed to be bauxite. However, the laboratory analysis was inconclusive, and the exact chemical formula for the powder is still unknown. The railcar contents are the property of GCC. As a result, RWQCB issued a letter to GCC requesting additional details concerning the nature of the powder. This potential source of aluminum to the Litigation Area was still unknown at the time this BERA was conducted. The decision to not include aluminum as a COPEC was based on an analysis of existing data. The analysis determined aluminum is currently not a risk driver in soil and sediment at the Litigation Area. However, the Navy will consider the implications of this potential ongoing source of contamination in all future investigations or monitoring events. The Navy will contact the railroad and chemical companies to inform them of any Navy concerns about ongoing spills. Additional discussion of aluminum concentrations in surface water is provided below.

Mercury did not exceed the ER-M for sediment, but sediment:clam BAFs were greater than 1.0 at several locations (Section 5.0). For this reason, mercury was added to the list of COPECs evaluated in the BERA.

Screen of Surface Water Samples

Table 57 presents total and dissolved concentrations of 20 metals measured using low-level CLP methods at 10 locations in the ditches, slough, and slough reference area during two dates in October 2000. Total and dissolved metal concentrations in each sample were compared with the chronic and acute surface water benchmarks described in Tables 10A and 10B.

Total aluminum concentrations exceeded the acute surface water benchmark (750 micrograms per liter [µg/L]) at all 10 locations sampled during October 2000; however, dissolved concentrations of aluminum at each of these same locations were all below the chronic surface water benchmark. Both availability

and toxicity of aluminum are known to increase with decreasing pH. The solubility of aluminum is greatest below a pH of 5.5; aluminum in sediment and water at circumneutral pHs (pH of 5.5 to 7.5) has been found to be relatively innocuous (Sparling and Lowe 1996). Because most of the aluminum in surface water is in the particulate phase and the average pH in soil, sediment, and water at the Litigation Area is well above 6.0, aluminum is not believed to pose a risk to fish and aquatic invertebrates and was not included in the list of COPECs evaluated in the BERA. As discussed above for sediment, in July 2001, the Navy observed a potential ongoing source of aluminum contamination from leaking railcars on ATSF property. Aluminum is currently not considered a risk driver in surface water at the Litigation Area. The Navy will discuss concerns about the leaking railcars with the railroad and chemical companies.

The chronic benchmark for total copper was exceeded at a single ditch location. The acute benchmark for dissolved copper was exceeded at one ditch location and at four slough locations.

Mercury exceeded the chronic but not the acute benchmark for total and dissolved metals at all 10 locations. At every location where either the total or dissolved chronic criterion was exceeded, however, mercury was below the detection limit, and concentrations were estimated based on the analytical DL. During the 5 years of postremediation monitoring, mercury was evaluated in RASS 4 only. Because all of the mercury results from October 2000 were based on ND data, inferences concerning actual risk should be made cautiously. As discussed for the sediment screen, the decision to include mercury on the list of COPECs evaluated in the BERA was based on the potential for bioaccumulation of mercury.

Dissolved concentrations of zinc exceeded the acute benchmark at a single ditch location.

Conclusions of the Screen for Surface Water

No additional COPECs were identified for the BERA based on surface water samples collected in October 2000.

3.1.3 Contaminants of Potential Concern Evaluated in the Baseline Ecological Risk Assessment

Based on (1) results and recommendations from the QEA (PRC 1997b), (2) results from the reevaluation of total DDT and PCB data from the QEA, (3) results from the 5 years of postremediation monitoring (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a), and (4) results from the October 2000 sampling event, the following chemicals were evaluated as COPECs in the BERA:

Chemical	Included as a COPEC?	Rationale for Inclusion or Rejection as a COPEC and How Evaluated in the Baseline ERA
Aluminum	No	Only total aluminum in surface water exceeded benchmarks; unlikely to be toxic because of high pH in Litigation Area soil, sediment, and surface water
Arsenic	Yes	Widespread in soil, sediment, and surface water; frequently exceeded benchmarks; fully evaluated for all receptor groups
Cadmium	Yes	Widespread in soil, sediment, and surface water; frequently exceeded benchmarks; fully evaluated for all receptor groups
Copper	Yes	Widespread in soil, sediment, and surface water; frequently exceeded benchmarks; fully evaluated for all receptor groups
Lead	Yes	Widespread in soil, sediment, and surface water; frequently exceeded benchmarks; fully evaluated for all receptor groups
Mercury	Yes	Estimated concentrations (all data ND) of mercury exceeded chronic total and dissolved surface water criteria; sediment:tissue BAFs for clams exceeded 1.0 at four locations; risk to fish and aquatic invertebrates and birds and mammals evaluated
Selenium	Yes	Widespread in soil, sediment and surface water; frequently exceeded benchmarks; fully evaluated for all receptor groups
Zinc	Yes	Widespread in soil, sediment, and surface water; frequently exceeded benchmarks; fully evaluated for all receptor groups
DDTs	Yes	DDTs infrequently detected in sediment, concentrations probably reflect anthropogenic background levels for San Francisco Bay; risk to fish and aquatic invertebrates and birds and mammals were evaluated in the BERA
PCBs/Aroclors	Yes	PCBs infrequently detected in sediment; risk to fish and aquatic invertebrates and birds and mammals were evaluated in the BERA

Notes:

BERA Baseline ecological risk assessment
COPEC Chemical of potential concern
DDT Dichlorodiphenyltrichloroethane
PCB Polychlorinated biphenyl

3.2 NATURE AND EXTENT OF TOTAL DICHLORODIPHENYLTRICHLORO-ETHANE AND POLYCHLORINATED BIPHENYL CONTAMINATION

Concentrations of total DDTs and total PCBs and Aroclors in soil and sediment are briefly discussed by habitat area. Further detail is provided in the exposure and effects assessment for invertebrates and fish in Sections 5.1.1 and 5.2.1, respectively, where location-specific concentrations of these organic compounds are compared with location-specific metals concentrations.

Total concentrations of PCBs, Aroclors, and DDTs were calculated based on the sum of congeners within each analyte group. For total PCBs, 18 congeners were summed, and the sum was then multiplied by 2.0 (National Oceanic and Atmospheric Administration 1993). Total Aroclors were calculated as the sum of seven individual PCB mixtures reported for each sample. Total DDTs were calculated as the sum of the 2, 4'- and 4, 4'- congeners for dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethene (DDE), and DDT. At each sampling location, only the depth (surface or subsurface) containing the highest total concentration is presented for each analyte.

The effect of high DLs and high frequency of ND data for total DDTs, total PCBs, and total Aroclors was assessed using a sensitivity analysis approach. Chemical concentrations were calculated for individual sampling locations using either one-half the DL or the full DL for each ND analyte. Additional details on the treatment of these data as part of the Navy's reevaluation of organic chemicals are provided in Sections 5.1.1 and 5.2.1.

3.2.1 Total Dichlorodiphenyltrichloroethane

DDT and its congeners were not detected in ditches or the marsh or upland reference areas. The highest detected concentration was 329 µg/kg total DDTs from a single location in the RASS 4 wetland; confirmation sampling showed that this maximum concentration was an isolated sample. All other detected concentrations detected across the site were less than the ER-M (Table 59). Concentrations of total DDTs in each habitat area are summarized in Table 58 (detected and ND results) and in Table 59 (detected results only). Table 60 provides the location-specific total DDT concentrations for each habitat.

Because most of the data were ND, an evaluation of the worst-case scenario substituting full DLs for ND data (see Table 58) shows maximum concentrations of total DDTs greater than the ER-M in the ditches, marsh surface, RASS 4 wetland, and slough. A more realistic evaluation using one-half the DL for ND data indicates maximum concentrations only in RASS 4 wetland above the ER-M. Table 61 provides a summary of DLs achieved for each DDT congener.

In general, DDT and its congeners were rarely detected, and only one detected concentration in RASS 4 wetland exceeded the ER-M. The sensitivity analysis of the effect of high frequency of ND data and relatively high DLs shows that even when the full DL is substituted for ND data, total DDTs were generally less than the ER-M. The widespread distribution, low concentrations, and predominance of DDD and DDE congeners are consistent with the legal and historic application of DDT for mosquito abatement, which is the assumed source of DDTs at this site. Additional discussion of the distribution of

DDT in sediment and comparison of the relative risk from DDT and inorganic contaminants is provided in Section 5.2.1.

3.2.2 Total Polychlorinated Biphenyls and Aroclors

Most of the sediment concentrations reported in the QEA (PRC 1997b) are for PCB mixtures (Aroclors) based on standard CLP methods; low-level method analysis of PCB congeners was conducted at only a few locations in the marsh and upland reference areas. Concentrations of total PCBs and Aroclors in each habitat area are summarized in Table 58 (detected and ND results) and Table 59 (detected results only). Table 62 provides the location-specific total PCB and Aroclor concentrations for each habitat. No ecologically based effects benchmarks are available for Aroclors.

PCB congeners were detected in a single sample from the marsh reference area and in three out of four samples from the upland reference area; concentrations of total PCBs were well below the ER-M in each of these samples (Table 59). Aroclors were detected at three locations in the RASSS 3 and 4 uplands and at a single location in the RASS 4 wetland and the slough (Table 59). The highest detected concentration of Aroclor (1,500 µg/kg) was detected in an upland location in RASS 3 (R03SS214); this area was subject to confirmation analysis during the QEA.

The vast majority of Aroclor results were NDs. Table 58 shows the sensitivity analysis of the effect of substituting the full DL or one-half the DL for ND data. Total Aroclor concentrations with either substitution are highest in the upland of RASS 3 and 4 and second highest in the ditches; these areas have the highest uncertainty with regard to true concentrations of Aroclors. Table 61 provides a summary of DLs achieved for each of the PCB congeners and mixtures.

PCBs or Aroclors were rarely detected across the site, and no known source exists other than the standard operations of railroad engines on the railroad tracks that cross the site. This BERA presents the results of a reevaluation of existing PCB and Aroclor data. Section 5.2.1 discusses the distribution of PCBs in sediment and risk to aquatic invertebrates and fish. Sections 6.3.1 and 6.3.4 discusses risk to higher trophic-level receptors that are exposed to PCBs and Aroclors.

The reevaluation results were presented to the regulatory agencies at a meeting on March 5, 2001. Discussions held at this and subsequent meetings identified three outstanding concerns:

1. Areas along the northern margin of RASS 3 bordering the Southern Pacific Transportation Company Railroad property have not been adequately characterized for PCBs

2. The upland area in RASS 3 along the railroad tracks near location R03SS214, where the highest detected concentration of total Aroclors was measured, should be further investigated

3. The CPC should be considered as a potential historical source of PCBs, and the possibility of PCB transport along Nichols Creek should be investigated

The Navy presented proposals to address these concerns to the regulatory agencies at a risk management meeting on March 27, 2002. In addition, the Navy proposed the collection and analysis of soil samples for PCB mixtures (Aroclors) in these three areas. Section 10.0 of the five-year review report details the Navy's proposals for addressing outstanding concerns related to PCB contamination .

3.3 NATURE AND EXTENT OF INORGANIC CONTAMINATION

The concentrations and distribution of the six metals in soil, sediment, and surface water are discussed briefly in the following sections. Data for characterizing the nature and extent of inorganic contamination are from the 5 years of postremediation monitoring and the October 2000 sampling event. Several analyses conducted as part of this characterization were in response to requests from the regulatory and trustee agencies that the Navy provide more detailed analysis of the variation in contaminant concentrations at individual point locations as well as a more focused assessment of outlier or "hotspot" concentrations of chemicals.

Box plots and tables show the soil and sediment concentrations of each metal at point locations within individual habitat areas during monitoring years 1 through 5 (Attachment G1). These figures show year-to-year variability in metal concentrations at point locations in addition to highlighting outlier or hotspot concentrations within each habitat. Color-coded maps illustrate the temporal and spatial distributions of each metal (Figures 22 through 33). Box plots and tables of the mean ER-M_q (Long and MacDonald 1998) for six metals are provided in Attachment G2 and discussed in Section 5.0.

A more detailed analysis of hotspot concentrations in soil and sediment was also conducted. All data from each sampling round at all point locations from the years 1 through 5 monitoring were pooled, and sitewide distributions were constructed for each metal. Summary statistics compiled for the sitewide concentrations of each metal are presented in Table 63. In this table, threshold concentrations are defined for the purpose of identifying hotspot locations for each metal. These thresholds define hotspot concentrations based on an operational definition for statistical outliers. Outlier or hotspot concentrations

are defined by adding a value equivalent to 1.5 times the interquartile range (the length of the boxes in the box plots, which is equal to the 75th percentile concentration minus the 25th percentile concentration) to the 75th percentile concentration (the upper margin of the boxes in the box plots) of the sitewide distribution for each chemical. An outlier or hotspot threshold has also been defined based on the mean ER-M_q for seven metals (the six original COPECs plus mercury) at the bottom of Table 63.

The definitions for hotspots were then used to prepare a series of summary tables. The number of hotspot locations within each habitat based on an exceeded threshold concentration for each of the seven metals and the mean ER-M_q is provided in Table 64. A location is included in Table 64 if it exceeded the hotspot threshold for any of the individual metals or the mean ER-M_q during any of the five rounds of sampling. Table 65 provides summaries of hotspot concentrations at individual locations for each metal. Table 65 is sorted by metal and by decreasing maximum hotspot concentration at each location. The number of times a location was identified as a hotspot is also provided in this table as well as the habitat where the location is found. Table 66 lists all locations identified as hotspots based on calculation of the mean ER-M_q for seven metals. Table 66 is sorted by decreasing maximum ER-M_q at each location and lists the habitat where each location is found as well as the number of times the location was identified as a hotspot during the 5 years of monitoring. Table 66 also summarizes the percent contribution of each of the seven metals to the calculation of the mean ER-M_q. Additional discussion of hotspot concentrations of metals in soil and sediment is provided in Sections 3.3.1 through 3.3.6.

A set of box plots and tables identical to those described for soil and sediment were prepared for each of the six metals using surface water data from monitoring years 1 through 5 (Attachment G3). Color-coded maps providing additional summary of the surface water data and showing the spatial relationships among sampling locations for each of the metals are provided on Figures 38 through 43. Additional summaries of total and dissolved surface water concentrations of metals and comparison to acute and chronic water quality benchmarks are provided in Tables 67 and 68, respectively.

Sections 3.3.1 through 3.3.6 provide brief descriptions of the extent of contamination by each of the six metals in sediment and surface water at the Litigation Area. The focus of these sections is on providing general descriptions of the sitewide distributions and relative concentrations of metals in soil, sediment, and surface water. Section 4.0 provides additional discussion of soil and sediment metal concentrations in terrestrial and wetland habitats as well as a comparison with toxicity benchmarks for plants. Additional summaries and a comparison of sediment and surface water concentrations of metals with toxicity benchmarks for fish and aquatic invertebrates are provided in Sections 5.0. Section 6.0 discusses the potential risk to birds and mammals exposed to metals in soil and sediment.

3.3.1 Arsenic

The highest soil and sediment concentrations of arsenic were detected in the southeastern portion of RASS 1 on the marsh surface in Unit 6 and in the ditches in Unit 7 (Figure 22). Scattered high concentrations were also detected at some locations in the slough in Units 10 and 11. This spatial distribution is consistent with the historic source of spills coming from the General Chemical Corporation (GCC) facility to the east and migrating into the slough over time (Figure 3). Arsenic was not detected in high concentrations relative to available benchmarks in RASSs 3 or 4 (Figure 23).

Hotspot concentrations of arsenic in soil and sediment were detected in 17 ditch locations, 18 slough locations, 25 marsh surface locations, 2 Nichols Creek locations, and 1 RASSs 3 and 4 upland location (Table 64).

Maximum surface water concentrations of arsenic were measured at locations in the southeastern portion of RASS 1 in the ditches in Unit 7, in the western arm of Lost Slough in Unit 11, and in the RASS 4 wetland (Figure 38 and Attachment G3). The 5-year, areawide mean concentrations of total arsenic were highest in the ditches (81.7 µg/L) and the RASS 4 wetland (33.8 µg/L) (Table 67).

3.3.2 Cadmium

The highest soil and sediment concentrations of cadmium were at detected in the southern ditches in the southeastern portion of RASS 1 (Figure 24). In addition, numerous locations in the slough (Units 10 and 11) contained high cadmium concentrations. A few locations in the creek bed and pond in RASS 3 contained cadmium concentrations greater than two times the ER-M (19.2 mg/kg), as shown on Figure 25.

Hotspot concentrations of cadmium in soil and sediment were detected at 15 ditch locations, 25 slough locations, 11 marsh surface locations, 5 Nichols Creek locations, 4 RASS 3 pond locations, and 6 locations in RASSs 3 and 4 upland (Table 64).

Maximum surface water concentrations of cadmium were found in the southeastern portion of RASS 1 in the ditches (Unit 7) and in the western arm of Lost Slough (Unit 11); concentrations were also elevated at a few locations in Nichols Creek (Figure 39 and Attachment G3). The 5-year, areawide mean concentrations of total cadmium were highest in Nichols Creek (6.44 µg/L) and the ditches (4.04 µg/L) (Table 67).

3.3.3 Copper

The highest soil and sediment concentrations of copper were detected in the southeastern portion of the marsh. Several locations exceeded four times the ER-M (1,080 mg/kg) in the marsh surface in Unit 6, the ditches in Unit 7, and in the marsh surface in RASS 2 (Figure 26). Scattered high concentrations are also detected in the slough (Units 10 and 11). This spatial distribution is consistent with the historic source in spills coming from the GCC facility to the east. Copper was not detected in high concentrations compared with available benchmarks in RASSs 3 or 4 (Figure 27).

Hotspot concentrations of copper in soil and sediment were detected in 20 ditch locations, 18 slough locations, 29 marsh surface locations, and 2 Nichols Creek locations (Table 64).

Elevated surface water concentrations of copper were widespread in each of the aquatic habitats at the Litigation Area (Figure 40 and Attachment G3). The 5-year, areawide mean concentrations of total copper were highest in the ditches (134.2 µg/L) and the RASS 4 wetland (110.6 µg/L) (Table 67).

3.3.4 Lead

The highest soil and sediment concentrations of lead were in the marsh surface of RASS 2 and adjacent marsh surface and ditch areas in RASS 1 (Figure 28). Concentrations rarely exceeded four times the ER-M (872 mg/kg). Lead has been detected consistently at concentrations greater than 872 mg/kg in a few locations in RASS 3, adjacent to the CPC facility (Figure 3) and downstream in the RASS 3 pond (Figure 41). Lead was also detected at consistently high concentrations in a few surface soil locations outside of the active remediation area in RASS 4.

Hotspot concentrations of lead in soil and sediment were found at 11 ditch locations, 4 slough locations, 30 marsh surface locations, 8 Nichols Creek locations, 3 RASS 3 pond locations, 1 RASS 4 wetland location, and 1 RASSs 3 and 4 upland location (Table 64).

Surface water concentrations of lead were generally low throughout the Litigation Area. Isolated elevated concentrations of lead occurred in the southeastern portion of RASS 1 in the ditches of Unit 6, in the slough (Units 10 and 11), in Nichols Creek, and the RASS 4 wetland. The 5-year, areawide mean concentrations of total lead were highest in the RASS 4 wetland (83.2 µg/L), ditches (38.6 µg/L), and Nichols Creek (37.9 µg/L) (Table 67).

3.3.5 Selenium

Concentrations of selenium in soil and sediment frequently exceeded the ER-M; many concentrations were detected between 1.4 mg/kg (the ER-M) and 5.6 mg/kg (4 times the ER-M). RASS 4 had the highest concentrations of selenium observed at the Litigation Area (657 mg/kg) (Figure 31). A few locations in the southeastern portion of RASS 1 exceeded 5.6 mg/kg. RASSs 2 and 3 typically had much lower concentrations than RASS 1 (Figure 30).

Hotspot concentrations of selenium in soil and sediment were detected at eight ditch locations, five slough locations, eight marsh surface locations, two Nichols Creek locations, two RASS 4 wetland locations, and five RASSs 3 and 4 upland locations (Table 64).

Surface water concentrations of selenium were generally below levels of concern (Figure 42 and Attachment G3). The 5-year, areawide mean concentrations of total selenium were highest in the Nichols Creek reference area (4.23 µg/L), Nichols Creek (2.15 µg/L), and the RASS 4 wetland (2.12 µg/L); mean concentrations were only slightly lower in the ditches (1.93 µg/L), the RASS 3 pond (1.62 µg/L), and the slough (1.51 µg/L) (Table 67).

3.3.6 Zinc

Zinc concentrations were elevated at many locations across the Litigation Area; this distribution likely reflects the historic role of Nichols Creek in transporting zinc from the source at CPC, downstream through RASS 3 into RASS 1. High concentrations of zinc in sediment occur across the southern portion of RASS 1, including the slough, ditch, and marsh surface habitats, and in isolated samples from RASS 2 (Figure 32). Most locations in the southern portion of RASS 1 contained zinc concentrations exceeding four times the ER-M (1,640 mg/kg); many concentrations were between 10,000 and 20,000 mg/kg, and one was as high as 89,300 mg/kg (Attachment G1). Concentrations in RASS 3 were typically less than the 5,000-mg/kg cleanup goal established in the FS report but greater than 1,640 mg/kg (four times the ER-M), especially near CPC property and in the RASS 3 pond (Figure 33). Hotspot concentrations of zinc in soil and sediment were detected at 9 ditch locations, 25 slough locations, 10 marsh surface locations, 13 Nichols Creek locations, 5 RASS 3 pond locations, and 1 RASSs 3 and 4 upland location (Table 64).

Maximum surface water concentrations of zinc were detected in the southeastern portion of RASS 1 in the ditches in Unit 7, in the western arm of Lost Slough in Unit 11, in Nichols Creek, and in the RASS 4 wetland. Elevated concentrations of zinc were occasionally detected in the main slough (Unit 10) and in

the ditches in Unit 3 (Figure 43 and Attachment G3). The 5-year, areawide mean concentrations of total zinc were highest in Nichols Creek (2,750 µg/L), the ditches (886 µg/L), the slough (621 µg/L), the RASS 4 wetland (526 µg/L), and the RASS 3 pond (459 µg/L) (Table 67).

3.4 CONCENTRATIONS OF ORGANIC AND INORGANIC CHEMICALS IN THE REFERENCE AREAS

Clean, unaffected sites have not been identified for the southern shore of Suisun Bay. Separate reference areas were identified for the main slough, marsh surface (Unit 1), and uplands (Unit 16). Reference areas were considered to be nominally impacted regions of the Litigation Area that could be used for comparison purposes in risk characterization. Risk to ecological receptors from chemical concentrations in the reference areas versus other portions of the site is discussed as part of risk characterization in Section 7.0. The suitability of each of these areas as reference areas, as well as the relative concentrations of organic and inorganic COPECs in each area, is discussed in the following sections.

3.4.1 Proposed Slough Reference Area

Based on the October 2000 sampling event, maximum concentrations of arsenic, chromium, copper, mercury, nickel, and zinc in sediment were between the ER-L and the ER-M in the proposed slough reference area (Table 55). Figure 10 compares concentrations of the six metals in the proposed slough reference area with the biased samples collected from known areas of contamination in the ditches and slough. This area cannot be considered a clean and unimpacted site; however, the Navy and regulatory agencies have been unable to identify any other suitable clean and unimpacted sites along the industrialized southern shore of Suisun Bay. Sediment concentrations are significantly lower in the proposed slough reference area than in the upper reaches of the slough; the proposed slough reference area has comparative value for making risk management decisions about more contaminated portions of the site. No DDT, PCB, or Aroclor data are available for the proposed slough reference area. Clam bioaccumulation and bioassay results from the proposed slough reference area are discussed in Sections 5.2 and 5.3.

3.4.2 Marsh Surface Reference Area (Spatial Unit 1)

Like the slough reference area, the marsh surface reference area cannot be considered a clean and unimpacted site; however, sediment concentrations are significantly lower in the marsh reference area than in portions of the site nearer the sources of contamination. As a result, the marsh reference area is considered representative of nonsite-related conditions in this area of Suisun Bay.

Based on the 5 years of monitoring, concentrations of cadmium are below the ER-L; some concentrations of arsenic, copper, lead, and zinc are between the ER-L and the ER-M; concentrations of selenium are occasionally above the ER-M. Concentrations of total DDTs and total PCBs and Aroclors are well below available benchmarks in marsh reference area sediment (Table 58).

3.4.3 Upland Soil and Nichols Creek Reference Area (Spatial Unit 16)

Based on the 5 years of monitoring, soil concentrations of arsenic, cadmium, copper, and zinc in the upland reference area are below the ER-L. Lead and selenium concentrations were between the ER-L and the ER-M in a few samples. Concentrations of total DDTs in soil were between the ER-L and the ER-M (Table 58). Total PCBs in soil were below the ER-L. The upland soil reference area is considered a suitable reference area for upland soils based on low chemistry.

Sediment and surface water of the lower portion of Nichols Creek were heavily affected by discharges from the CPC property and other off-site sources of contaminants. Concentrations of most metals were low in sediment and surface water upstream of the discharge points; however, surface water concentrations of lead, mercury, and zinc were elevated in the upstream reference area. The 5-year, areawide averages for total lead (18.6 µg/L) and mercury (0.06 µg/L) exceeded the respective chronic benchmarks for each of these metals. The 5-year, areawide average for total zinc in the upstream reference area (91.2 µg/L) exceeded the chronic (85.6 µg/L) surface water benchmark. The 5-year, areawide average for total selenium (4.23 µg/L) was below the chronic surface water benchmark (5.0 µg/L). No DDT or PCB and Aroclor data are available for this portion of Nichols Creek.

4.0 EXPOSURE AND EFFECTS ASSESSMENT FOR PLANTS

The evaluation of risk to plants from the six inorganic COPECs (arsenic, cadmium, copper, lead, selenium, and zinc) at the Litigation Area focused on updating the assessment conducted in the QEA (PRC 1997b). Because uptake and translocation of DDTs and PCBs in plants is not expected to occur at concentrations measured at the Litigation Area (Bell and Faileys 1991), no risk assessment was performed on these organic compounds. The following lines of evidence were used to assess risk to plants:

- Comparison of site soil chemistry with ORNL plant toxicity benchmarks (Efroymson and others 1997)
- Comparison of site-specific soil and tissue concentration data with effects levels published since the literature review performed for the QEA

- Calculation of BAFs to evaluate uptake and accumulation by pickleweed tissue of the six inorganic COPECs (arsenic, cadmium, copper, lead, selenium, and zinc)
- Qualitative evaluation of the association of pickleweed percent cover with concentrations of metals

The following sections provide an exposure and effects assessment for plants at the Litigation Area. Plant communities and special status species are introduced in Section 4.1. The exposure assessment, which includes an evaluation of spatial variation in site chemistry and plant bioaccumulation, is provided in Section 4.2. The results are summarized in Section 4.3.

4.1 PLANT COMMUNITIES AT THE LITIGATION AREA

Suisun Bay is a transition zone between the marine influence of San Francisco Bay and the freshwater influence of the Sacramento and San Joaquin rivers. The lower wetland portion of RASSs 1 and 2 is a dynamic brackish tidal marsh. The drier upland portions of the Litigation Area, particularly RASSs 3 and 4, are essentially disturbed grasslands, except for a small freshwater marsh in RASS 4 and the pond in RASS 3. The RASS 3 pond, which is tidally influenced, has been colonized by freshwater and brackish plants and animals since it was created during the remedial action.

A vegetation characterization study was conducted in 1991 (PRC 1994) and again in 1995 (PRC 1996b). Surveys for special status species were conducted yearly from 1996 to 1999 (see Appendix D or TtEMI 2000a).

4.1.1 Tidal Wetland Vegetation

Based on a review of the vegetation assemblage boundaries depicted on the map developed from aerial photographs and verified through walkover surveys (PRC 1996b), plant species dominant in the tidal wetland include common pickleweed *(Salicornia virginica*) and salt grass (*Distichlis spicata*). Codominant species include perennial peppergrass (*Lepidium latifolium*), marsh gum plant (*Grindelia hirsutula* var. *hirsutula*), olney bulrush (*Scirpus americanus*), and California bulrush (*Scirpus californicus*). Pickleweed and salt grass commonly occurred as sole dominants in many areas, but they also combined to form dominant and subdominant stands in the tidal wetland. Perennial peppergrass occurred in pure stands and as a codominant species, with as many as 10 different species throughout RASS 1. Other species included perennial ryegrass (*Lolium perenne*), Baltic rush (*Juncus balticus*), jaumea (*Jaumea carnosa*), and ripgut grass (*Bromus diandrus*). Interspersed patches of common reed (*Phragmites australis*) and narrow-leaved cattail *(Typha angustifolia*) also were found. The transitional

wetland area of RASS 2 supports common pickleweed, alkali heath (*Frankenia salina*), spear oracle (*Atriplex patula* var. *patula*), ripgut grass, and Baltic rush.

The initial vegetation characterization followed a period of prolonged drought in northern California. During the drought, fresh water inputs through the delta to Suisun Bay also decreased, allowing more saline water from the outer bay to move into Suisun Bay. Freshwater flow through the delta is intensively managed and has not reflected natural seasonal cycles for several decades. The patterns of plant diversity and dominance documented in the 1991 survey (PRC 1994) represent a snapshot in time. The tidal wetland has undergone considerable change in the extent and distribution of vegetation since 1991, with brackish wetland species appearing to increase relative to salt marsh species based on the 1995 survey and subsequent observations.

In addition to natural and induced variability in the input of freshwater to the tidal marsh, the introduction and spread of nonnative plant species also influences current patterns of plant diversity and distribution. For example, perennial peppergrass and common reed have dramatically increased in lateral distribution since 1991. The invasive nature of these nonnative species is well documented and not unique to the Litigation Area. Both perennial peppergrass and common reed are less salt tolerant than the typical native salt marsh species, and their growth may be favored in period of increased freshwater flow. The peppergrass, in particular, appears to be colonizing the low spoil banks that line the ditches, effectively using the ditches as invasion corridors into the marsh. In general, lower elevations in the marsh support more pickleweed, with peppergrass occurring at higher elevations, such as along the ditches. The role of disturbance in the spread of invasive plant species should be considered further if additional remedial actions are implemented.

The vegetation within the small tidally influenced wetland in RASS 3 is dominated by narrow-leaved cattail and alkali bulrush (*Scirpus robustus*). Several yellow willow trees (*Salix lucida* ssp. *lasiandra*) grow on the eastern side of the pond. A small area on the southwestern side of the RASS 3 pond is dominated by pickleweed and saltgrass.

4.1.2 Nontidal Wetland Vegetation

The nontidal wetland vegetation within the small wetland in RASS 4 is dominated by narrow-leaved cattail and alkali bulrush. Other plants include saltgrass and pickleweed. Coyote brush (*Baccharis pilularis*) occurs to a limited extent in the surrounding area.

4.1.3 Upland Vegetation

According to the 1995 vegetation characterization, the upland area of RASSs 2 and 3 are vegetated by nonnative grasses and herbs, especially ripgut grass, perennial peppergrass, perennial ryegrass, and oatgrass (*Avena* sp.) (PRC 1997b). As part of the postremediation revegetation, a portion of the RASS 2 upland was revegetated with marsh gum plant and coyote brush in the summer of 1995, and the north-central region of RASS 3 was seeded with native grass species (including California brome (*Bromus carinatus*), purple stipa (*Stipa pulchra*), California fescue (*Festuca californica*), and wildrye (*Gramineae Elymus* sp.).

Ripgut grass, yellow star thistle, and coyote brush were the most common species during the RASS 4 characterization study. The central RASS 4 upland was planted with coyote brush and seeded with native grass species in 1995, after it was remediated. The reseeding was largely unsuccessful, however, as native grasses were overtaken by the introduced yellow star thistle, which now covers nearly 100 percent of the area where native grasses were sown. The upland reference area is dominated by ryegrass and Mediterranean barley (*Hordeum marinum* spp. *gussoneanum*).

4.1.4 Special Status Plant Species

Special status plant species were found in portions of RASS 1, the marsh reference area, and the northwestern portion of RASS 3 during annual surveys from 1995 to 1999 (see Appendix D or TtEMI 2000a).

- Soft bird's-beak (*Cordylanthus mollis* ssp. *mollis*) (Federal Endangered: California Rare)
- Mason's lilaeopsis (*Lilaeopsis masonii*) (Federal Species of Concern: California Rare)
- Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*) (Federal Species of Concern: No State Listing)
- Suisun marsh aster (*Aster lentus*) (Federal Species of Concern: No State Listing)
- Marsh gumplant (*Grindelia stricta* var. *augustifolia*) (No Federal Listing: No State Listing: California Native Plant Society [CNPS] List 4 species [a watch list for plants of limited distribution])

The federally endangered soft bird's-beak is found in coastal salt marshes and swamps in brackish tidal wetlands characterized by infrequent, brief inundations, and is known from fewer than 10 occurrences in California. Clumps of this clonal plant occur in several locations within the northern half of RASS 1. Most occurrences were within and adjacent to the active remediation area of RASS 1; soft bird's beak has

naturally recolonized the active remediation area of RASS 1. They are also found in the northwestern portion of the site, including the marsh reference area. The soft bird's-beak was typically associated with common pickleweed and saltgrass. Surveys indicate interannual variability in population size of soft bird's-beak but a general upward trend (Appendix D). Such natural variation in population size is typical of *Cordylanthus* (Ecorp•Sugnet 1998).

Mason's lilaeopsis, a California rare plant, is threatened throughout its range by development, flood control projects, recreation, erosion, levee maintenance, and agriculture. Mason's lilaeopsis grows on low, stable, wet banks of the bay and lower delta in brackish water with frequent tidal inundation. Only a few populations (four confirmed) were identified during the 1999 survey. Specimens were intermixed with three-ribbed arrow-grass (*Triglochin striata*), low club-rush (*Scirpus cernuus*), and occasionally Baltic rush. Erosion of the bank along Suisun Bay has reduced the amount of suitable habitat for Mason's lilaeopsis.

The delta tule pea, a California special plant, occurs in brackish tidal marshes and swamps, is threatened by agriculture and water diversions. The delta tule pea was found at several locations in northern RASS 1, along Lost Slough, and in the marsh reference area. Populations identified in the 1999 survey supported several fewer individuals than documented in 1998. Over 600 individuals were identified within RASS 1 during the 1999 survey as compared with approximately 1,500 individuals in 1998 and 500 individuals documented during 1997. The population is largely confined to the Suisun Bay shoreline vicinity and margins of sloughs dominated by large standing plants such as broad-leaved cattail, mugwort, perennial peppergrass, and olney bulrush.

The Suisun marsh aster, a California special plant seriously threatened by loss and alteration of tidal wetland habitat, grows along among cattails along brackish and freshwater tidal streams. Twenty-eight clumps of the Suisun marsh aster (many consisting of several thousand individuals) were documented during the 1999 survey. Most Suisun marsh aster are in RASS 1, but two clumps are in the northwestern portion of RASS 3. The Suisun marsh aster in the Litigation Area is usually near water channels and ditches and is associated with western goldenrod (*Euthamia occidentalis*), Baltic rush, marsh gumplant, American bulrush, water parsley (*Denanthe sarmentosa*), and perennial peppergrass. The dramatic increase in the Suisun marsh aster population since 1991 is attributed to favorable climatic conditions during the late 1990s.

Marsh gumplant is a locally abundant composite associated with brackish marshes in the region. It is common along ditches and other densely vegetated portions of RASS 1. The population of gumplant was

not mapped during the 1999 investigation because of its abundance and wide distribution. Marsh gumplant is neither rare, threatened, nor endangered, but it is on the CNPS Species List 4.

Distribution and abundance of special status plants in the Litigation Area have fluctuated during the last 5 years (Appendix D). These fluctuations are attributed to natural and anthropogenic variations in growing conditions, such as the input of fresh water in the form of rainfall and discharges from the delta. The confounding effect of variation in growing conditions on the spread of invasive plants such as perennial peppergrass and common reed are well beyond the scope of this report, but the effect should be considered during any future remedial design phase.

4.2 EXPOSURE AND EFFECTS ASSESSMENT

Protecting the wetland and upland plant populations from direct toxic effects of chemicals in soil on survival, reproduction, and growth are the assessment endpoints. Quantitative measures of exposure of plants to COPECs and the evaluation of potential effects from COPECs were based on the following three principal lines of evidence:

1. Soil HQs based on collocation of sensitive plants with concentrations of COPECs purported to be phytotoxic, as described by the ORNL benchmarks
2. Soil:plant BAFs greater than 1.0
3. Variation in plant community metrics along a chemical concentration gradient

Refinement of the exposure assessment considered factors affecting bioavailability, such as pore water and sediment extraction data, and other factors affecting uptake and accumulation of COPECs by plants. These topics are presented in the following sections.

4.2.1 Exposure Pathways

The most prevalent pathways by which vascular plants are exposed to chemicals are root absorption of contaminants in soil solution, leaf cuticle absorption of volatile or aerial suspended contaminants, and contaminated soil contacting the vegetative parts of the plant. For plants that are inundated, leaf absorption of dissolved chemicals in water is also an exposure pathway. Contaminants absorbed through roots can be translocated through the vascular system to other portions of the plant. Dissolved contaminants contacting leaves or stems can penetrate the cuticle and enter the free spaces of the leaves or stems (Hughes 1981). The fate and rate of transport of contaminants within leaves or stems is determined by the age of the vegetative part, the form of the contaminants, and the microenvironment. Once inside

the leaf or stem, the contaminants will either be bound and localized or will cross the membrane of the sieve cells and be translocated (Hughes 1981). In summary, dissolved chemicals that may enter a plant via roots, leaves, or stems will either be bound or translocated.

Salt marsh plants (halophytes) typically absorb both water and salt from the soil through their roots and excrete salt through salt glands to reduce osmotic pressure. A variation of this mechanism is seen in common pickleweed, which holds salt in vegetative portions to maintain osmotic pressure (Ornduff 1974). This natural regulating mechanism may limit the translocation of contaminants from the roots to aboveground parts of the plant. Although some plants can also absorb water and chemicals through the leaves, studies on partially submerged cattails and salt marsh cord grass in contaminated lakes and saltwater marshes showed that uptake from the water column was negligible (Breteler and others 1981; Duskenko and others 1995).

Exposure pathways to upland plants are essentially identical to wetland plants; however, in upland areas, salt stress is reduced, and contaminants are more likely to be oxidized. Bioavailability of chemicals is influenced by precipitation, organic matter, and other nutrients.

4.2.2 Assessment Endpoints

Because common pickleweed provides habitat and forage for the salt marsh harvest mouse and is widespread throughout the RASS wetlands, it was used as a surrogate for evaluation of wetland plants. Pickleweed, because of its widespread distribution, is exposed to the entire range of contaminant levels at the Litigation Area, allowing for spatial analysis of potential toxicological effects.

Common pickleweed is a colonial halophyte that forms dense stands in wetland areas and reproduces both vegetatively and by seed. Pickleweed occurs in the midzone of salt marshes, where it is inundated only during the highest tides. It absorbs salt and water through its roots from the soil and stores salt in aboveground tissues. Eventually, the excess salt is excreted to the tips of stems, which then desiccate and fall off the plant.

In general, habitat quality is not high in the upland areas. Because the majority of plants are nonnative invasive grasses, no surrogate species were identified for the evaluation of risk to upland plants.

4.2.3 Measures of Exposure and Effects

Each of the lines of evidence for risk to plants is described in the following sections. Section 4.2.3.1 compares bulk soil concentrations with phytotoxicity benchmarks. Section 4.2.3.2 presents the soil:plant

BAFs. An analysis of plant community metrics along a concentration gradient is presented in Section 4.2.3.3. Section 4.2.3.4 discusses the potential adverse effects of COPECs on plants.

4.2.3.1 Comparison of Soil and Sediment Concentrations to ORNL Plant Toxicity Benchmarks

Assessment of exposure of plants to COPECs requires that some concentration benchmark be established for comparison. In the absence of applicable regulatory standards for soil, comparisons were made primarily to ORNL plant toxicity benchmarks (Efroymson and others 1997), supplemented by other effect levels in the published literature.

Soil phytotoxicity benchmarks are difficult to apply universally because of the widely divergent physiochemical properties of soils. General phytotoxicological effects of chemical exposure include chlorosis, growth retardation, reduction in seed germination, and altered enzyme activity in plants. Soil factors, such as soil pH, organic content, and ion exchange capacity, can enhance or inhibit these effects in plants. In addition, the presence of multiple contaminants can cause synergistic or antagonistic effects. Evaluation of potential risk to plants was based on the maximum concentrations measured in soil and sediment across all sampling locations, bioaccumulation of COPECs by pickleweed, and information on adverse effects of contaminants on plants from the literature.

To identify concentrations at which toxicity to plants might occur from exposure to COPECs, soil and sediment concentrations were compared with ORNL toxicity benchmarks for plants. The ORNL benchmarks were based largely on lowest-observed-effect concentrations (LOEC) to agricultural plants; the uncertainty resulting from the use of these benchmarks to assessment risk to halophytes is discussed in Section 7.6.

Summary statistics provided in Table 69 are based on first calculating the years 1 through 5 mean concentration of chemicals at individual sampling locations and then calculating areawide averages for habitat areas using the location means. Minimum, median, and maximum 5-year averages are provided for each habitat area. A grand or areawide mean, standard deviation, and UCL_{95} was also calculated. Table 69 indicates whether the UCL_{95} concentration within a habitat area exceeded the ORNL LOEC benchmark and reports the number of locations where the 5-year average concentration exceeds the benchmark.

Sampling locations where soil concentrations were 10 times the ORNL were considered to pose a potential risk to plants. At RASS 1, arsenic and zinc frequently exceeded the ORNL benchmarks of

10 and 50 mg/kg, respectively. At five locations in the southeastern area (Unit 6), arsenic was more than 100 times the benchmark. Zinc exceeded the benchmark by a factor of 100 at two locations (Figure 77). No locations in RASSs 3 or 4 exceeded the ORNL benchmarks by a factor of 10.

Special status plant species (Suisun marsh aster, soft bird's beak, delta tule pea, and Mason's lilaeopsis) occur primarily in northern RASS 1, where concentrations of COPECs are lowest; however, at several locations along the Lost Slough, elevated arsenic and zinc concentrations co-occur with the Suisun marsh aster (Figure 77).

4.2.3.2 Bioaccumulation in Plants

Plants growing on soils containing high concentrations of metals may accumulate these chemicals in both the roots and the aboveground portion of the plant. Although copper and zinc are essential trace nutrients in plants, they are toxic at high concentrations. The other four COPECs are not essential to plants. Factors that determine the availability of metals for plant uptake include oxidation-reduction potential (redox), pH, ion exchange capacity, and organic and clay content of the soil. For most of the metals occurring at the Litigation Area, the roots of the plant are expected to be the main site of accumulation. Bioaccumulation of metals in plants is species specific; however, contaminants are generally measured at decreasing concentrations from roots to leaves, stems, fruits, and seeds.

In 1991, samples of dead and living plant tissue were collected from randomly placed grids at each sampling location, and analyzed for the six COPECs (PRC 1994). Groups of plants for which tissue were collected included grasses, halophytes, herbs and forbs, thistle, shrubs, and miscellaneous plant matter. Whole plants, including roots and shoots, were collected. Plant accumulation data and associated soil chemistry data were summarized in Appendix P of the QEA (PRC 1997b).

In 1995, samples of pickleweed tissue were collected from a subset of RASS 1 and marsh reference area locations; pickleweed was collected within 1 meter of the soil sampling locations (n = 17 locations) (PRC 1997b). Upright green and horizontal rhizomatous brown tissue was clipped from the plants closest to the soil sampling location. Dry weight concentrations of the six metals analyzed in pickleweed tissue are summarized in Table 70.

For both the 1991 and 1995 plant samples, concentrations in tissue were compared with concentrations in soil to estimate potential bioaccumulation. A BAF was estimated as follows:

$$BAF = [\text{Tissue Concentration}] / [\text{Soil or Sediment Concentration}]$$

For chemicals that were not detected in tissue, the DL from the tissue analysis was substituted for the plant tissue concentration.

1991 Plant Tissue Residue Data

Since the 1991 plant samples were collected from areas outside of the active remediation area, the results are considered representative of availability and accumulation of COPECs in unremediated areas. BAFs for cadmium, copper, lead, and zinc were higher in dead plant samples than in live plant samples from the wetland. For example, the maximum BAF for copper was 83 in dead plants but approximately 1.0 in live plants. The selenium BAFs in the wetland area were high in the halophytes and grasses (maximum halophyte BAF was 381), while the rest of the BAFs averaged about 30.

In the upland areas, the highest BAFs for cadmium (ranging between 4.35 to 6.48) were in thistle. The highest zinc and selenium BAFs were in dead plant matter also (12.04 and 841, respectively).

1995 Pickleweed Tissue Residue Data

BAFs for all metals at each of the 17 sampling locations were less than 1.0 for both green and brown pickleweed. Zinc was detected in plants at all 17 locations, and copper was detected at 15 locations. Selenium was not detected in either green or brown tissue at any location. Concentrations of metals in tissue, frequency of detection, and DLs are shown in Table 70.

4.2.3.3 Comparison of Plant Community Metrics to Metal Concentrations in Soil and Sediment

In the draft final work plan (TtEMI 2000e), the Navy proposed a qualitative evaluation of the association of plant community metrics, such as percent cover and mean height, with concentrations of metals in soil and sediment as a line of evidence in the risk assessment for plants. Data collected in the year 5 monitoring effort from vegetation characterization quadrants at locations where small mammals were trapped was used in this evaluation. Vegetation data from 10 small mammal transects (T1 through T10) and five small mammal grids were used; 560 small mammal trap locations were included. Percent cover and mean height of the dominant plant species were recorded for each 1-square-meter sampling quadrant, centered over the individual trap positions along each of the vegetation transects (or grid rows, as described below).

To evaluate the association of plant community metrics with soil concentrations, soil concentrations from locations closest to each of the grids or transects were used. Median soil concentrations from all locations within a 100-foot (radius) of each transect or grid were pooled and defined the soil concentrations for those quadrants. Metal concentrations used in this analysis were areawide median concentrations calculated using data for individual sampling rounds from the 5 years of monitoring at each location. Ideally, an evaluation of plant metrics and soil concentration would be based on samples collocated in time and space. The type of retrospective analysis attempted for this report was limited by the high variability among soil samples in the pooled groups from which median soil concentrations were drawn. The lack of collocation restricts the scope of the correlation analysis. The vegetation data set was considered most suitable to support evaluation of the relationship between pickleweed percent cover and soil concentrations.

Vertical needle plots and box plots show changes in pickleweed percent cover along a gradient of increasing concentration of metals (Figure 78). The vertical needles in each plot show pickleweed percent cover in each of the quadrants (corresponding to small mammal trap positions). Individual transects (for example, T5 and T6) and grids (for example, GRID 3 and GRID 4) are also shown. The parallel rows within each of the grids are labeled with capital letters (for example, A, B, and C). The numbers on the x-axis are the sequential sampling locations that correspond to the small mammal trap locations. Maps showing the location of the transects and grids, as well as additional descriptions and raw results from the vegetation monitoring, were provided in the year 5 monitoring report (Appendix C) (TtEMI 2000a). Soil concentrations for individual metals are presented as a panel of box plots above the needle diagrams for the percent cover data. The points in each of the box plots reflect concentrations measured during all sampling rounds at each of the pooled locations. The box plots are ordered by increasing median concentration of metal in sediment. The gray lines through the middle of each box plot are the grand means for all sampling rounds and locations.

Both pickleweed percent cover and soil concentrations were highly variable. The absence of an expected trend is notable; pickleweed percent cover is as great or greater at areas of the highest concentrations of metals than it is in areas with lower metal concentrations (Figure 78). This finding, however, may simply be an artifact of the procedure for characterizing average metal concentrations for each of the transects or grids. Other approaches for evaluating relationships between plant metrics and soil concentrations (for example, scatter plots and correlation analysis) were considered but rejected based largely on the absence of collocated data.

Results of the analysis of plant metrics along a concentration gradient were not considered useful for evaluating risk to pickleweed. As the data sets for other plant species were even less robust than the pickleweed data set, no additional evaluation was performed.

4.3.3.4 Toxicological Effects of Chemicals of Potential Ecological Concern

A literature search was conducted to identify toxicological effects of COPECs to wetland plants. Potential adverse effects of COPECs on plants are described in the following text and are summarized in Table 71. The literature on metal phytotoxicity reflects the interspecific variability in effect levels that has hampered the development of a generally applicable set of toxicological benchmarks for plants. As mentioned regarding the ORNL benchmarks (Efroymson and others 1997), most phytotoxicity studies focus on economically valuable species such as agricultural crops. Supplemental data gathered from phytotoxicological studies using salt marsh species are presented in the following text.

Arsenic

The 5-year maximum average concentrations of arsenic were 1,013 and 127 mg/kg in wetland and upland soil locations, respectively (Table 69). For freshwater cattail, arsenic has been reported to cause decreases in root growth at root concentrations of 1.0 mg/kg and to terminate root growth at 3.0 mg/kg. At sediment concentrations of 300 mg/kg, arsenic reportedly caused vegetative growth reduction (Peterson and others 1981; Duskenko and others 1995; Tamaki and Frankenberger 1992). In general, arsenic stunts plants but does not readily bioaccumulate in plants (Peterson and others 1981; Tamaki and Frankenberger 1992).

Cadmium

The 5-year maximum average concentrations of cadmium were 12.5 and 5.0 mg/kg at wetland and upland soil locations, respectively (Table 69). In smooth cordgrass and salt grass, cadmium caused reduced growth at sediment concentrations of 50 mg/kg (Gambrell and others 1980). At 73-mg/kg cadmium, reduced shoot and root biomass were observed in freshwater cattail (McNaughton and others 1974). For corn and sunflower crop plants, soil concentrations between 5 and 10 mg/kg caused decreases in net photosynthesis and water uptake as well as increases in leaf chlorosis (Carlson and others 1975; Miles and Parker 1980). Where soil salinity was increased, cadmium sediment concentrations of 0.1 mg/kg caused a decline in seed germination for the intertidal salt marsh cord grass (Mrozek 1980).

Copper and Zinc

Copper and zinc are essential trace metals for plants. The 5-year maximum average concentrations of copper at wetland and upland soil locations were 881 and 75.9 mg/kg, respectively; 5-year maximum average concentrations for zinc were 5,435 and 1,550 mg/kg, respectively (Table 69). The plant requirements of these two elements are presumed to be well below the highest concentrations measured in soil at the Litigation Area. High concentrations of copper in soil can reduce root length and enzyme activity as well as produce chlorosis (Lepp 1981; Foy and others 1978). For smooth cordgrass, a sediment concentration of 165-mg/kg copper was shown to cause shorter epicotyis and fewer radicles (Waddell and Kraus 1990).

For the freshwater cattail, zinc caused decreases in shoot and root biomass at sediment concentrations of 5,000 mg/kg, compared with plants grown in sediment with 13-mg/kg zinc (McNaughton and others 1974). Zinc in acidic soils was toxic to corn at concentrations of between 450 and 1,400 mg/kg of available zinc; concentrations of available zinc between 180 and 700 mg/kg caused toxicity in cowpeas (Gall and Barnette 1940, as cited in Adriano 1986). Zinc toxicity causes growth retardation, chlorosis, membrane "leakiness," and reduced photosynthesis (Collins 1981). Mrozek and Funicelli (1982) reported no increase in zinc toxicity to salt marsh cord grass along a gradient of increasing salinity. Concentrations of copper and zinc at the Litigation Area that greatly exceed reported background levels may pose a risk for plants at certain locations.

Lead

The 5-year maximum average concentrations of lead were 1,225 and 1,520 mg/kg in soil at wetland and upland area locations, respectively (Table 69). Lead is not generally as available in soils as the other metals and is not translocated; it is not translocated because of inhibitory mechanisms in plant roots (Malone and others 1974; Koeppe 1981). McNaughton and others (1974) observed reduced shoot and root biomass at 435-mg/kg lead (compared with plants grown in soil with 27 mg/kg). Carlson and others (1975) reported that concentrations of lead in soil of 500 mg/kg caused no adverse effects in corn and sunflower crop plants.

Selenium

Limited literature reports the toxicity of selenium to plants. The 5-year maximum average concentrations of selenium in soil at wetland and upland area locations were 7.1 and 152.5 mg/kg, respectively (Table 69). This concentration is higher than in nonseleniferous soils and can cause chlorosis as well as

general symptoms resulting from selenium substitution for sulfur in proteins and nucleic acids (Collins 1981).

4.3 POTENTIAL EFFECTS ON PLANTS

In the wetlands of the Litigation Area, the assessment endpoint was sufficient rates of survival, growth, and germination to sustain populations of wetland plants. Common pickleweed, which is a representative species for wetland plants, is found throughout the wetlands, including the most contaminated southeastern area of RASS 1. The five special status species (Suisun marsh aster, soft bird's beak, delta tule pea, Mason's lilaeopsis, and marsh gumplant) are primarily in the northern portion of RASS 1, along the margins of Suisun Bay, and along the Lost Slough (Figure 77). In the upland area of the Litigation Area, the assessment endpoint was sufficient rates of survival, growth, and reproduction to sustain populations of upland plants.

Common pickleweed is the most widespread plant species in the Litigation Area (Figure 76), providing structure to the marsh as well as cover and forage to the salt marsh harvest mouse. In the southeastern area of RASS 1, high concentrations of arsenic and zinc are collocated with dense stands of pickleweed, where no signs of adverse effects to pickleweed are apparent. Furthermore, soil:pickleweed BAFs indicate that COPECs are not being accumulated in this plant (BAFs less than 1.0). In the wetland area, the greatest threat at a community level to the plant assemblages and common pickleweed habitat is probably the invasive perennial peppergrass and common reed.

The five special status plant species occur primarily in the northern portion of RASS 1, along the margins of Suisun Bay, and along the Lost Slough (Figure 77). The northern area of RASS 1 has low concentrations of contaminants. Soft bird's beak is also found at the edge of the active area in RASS 1, which is contaminated with zinc and arsenic. Soft bird's beak is a federally endangered species, and the small population at this location is potentially at risk; however, plant surveys conducted from 1996 through 1999 show that soft bird's beak has spread in this general area, despite elevated metal concentrations, and has readily colonized the active remediation area (Appendix D). Suisun marsh aster has spread along the slough in Unit 11 and ditches in Unit 7 in areas where arsenic and zinc are elevated.

Upland plant communities at the Litigation Area are typical of disturbed areas, dominated by nonnative grasses. At some locations, plants may be affected by concentrations of contaminants that exceed ORNL benchmarks. No special status plant species exist in the upland areas.

5.0 EXPOSURE AND EFFECTS ASSESSMENT FOR FISH AND AQUATIC INVERTEBRATES

Section 5.1 describes the fish and aquatic invertebrate communities at the Litigation Area. Section 5.2 discusses the potential for exposure of fish and aquatic invertebrate receptors to DDTs, PCBs, and metals across the Litigation Area and potential effects. Section 5.3 discusses the bioavailability of chemical contaminants and the potential for bioaccumulation by fish and aquatic invertebrates. The characterization of risk to fish and aquatic invertebrates from chemical contaminants is addressed in Section 7.3; uncertainties associated with the risk assessment are discussed in Section 7.6.

5.1 FISH AND AQUATIC INVERTEBRATE COMMUNITIES AT THE LITIGATION AREA

The primary aquatic habitats that support communities of fish and benthic invertebrates at the Litigation Area are: the tidal wetland, including sloughs and ditches, the RASS 3 pond, and the RASS 4 wetland. The area offshore from the site is located in the southeastern portion of Suisun Bay and consists of subtidal habitat. The offshore area is a transition zone between the marine environment of San Francisco Bay and freshwater conditions that exist in the Sacramento and San Joaquin rivers. Suisun Bay is hydrologically connected to the Litigation Area tidal wetlands and is an important rearing area for estuarine and freshwater fish and invertebrate species, as well as a migration corridor for fish that leave the bay to spawn in freshwater rivers and streams.

The largest aquatic habitat at the Litigation Area consists of tidally influenced wetlands covering approximately 225 acres of the 308-acre Litigation Area and represents one of a limited number of Suisun Bay tidal wetlands that provide habitat for special status species. The RASS 3 pond is tidally influenced and hydrologically connected to the main slough in RASS 1; fish and invertebrates are present. Aquatic invertebrates and fish in the tidal wetland are found primarily in the slough, and to a lesser extent in the network of mosquito ditches.

The RASS 4 wetland is a small, freshwater wetland that is fed by upland runoff through a drainage ditch from the northwest, but is typically dry during the summer months and does not support fish populations.

Detailed physical descriptions of aquatic habitats at the Litigation Area, as well as discussions of the natural history of fish and aquatic invertebrate communities and results of biological surveys conducted at the site, are provided in the QEA (PRC 1997b). The following sections briefly summarize the descriptions from the QEA.

5.1.1 Fish Communities

Suisun Bay provides habitat for a large number of native and introduced fish species. These species include freshwater, anadromous, estuarine, and marine fishes. Marine species may use Suisun Bay during certain life stages (for example, juvenile rearing) or during periods of elevated salinity in San Francisco Bay. In recent years, the abundance of many native species and some introduced species has declined for a variety of reasons, including water diversions, reduced freshwater inflow, habitat loss, pollution, over fishing, reduced prey abundance, and competition from dozens of introduced species. Fish communities of Suisun Bay include benthic (bottom-dwelling) fish and pelagic fish (those species that generally inhabit the middle and upper portions of the water column).

Typical native benthic fish species of Suisun Bay include the starry flounder (*Platichthys stellatus)*, the staghorn sculpin (*Leptocottus armatus*), and the white sturgeon (*Acipenser transmontanus*). A common introduced species is the yellowfin goby (*Acanthogobius flavimanus*). These bottom-dwelling fish tend to be in continuous contact with sediment and feed on the benthos. The starry flounder is typical of many benthic fish in that it uses the bay as juvenile rearing habitat. It is the most abundant benthic fish in Suisun Bay based on otter trawl surveys (Herbold and others 1992).

Pelagic fish in Suisun Bay include native species such as longfin smelt (*Spirinchus thaleichthys*), delta smelt, northern anchovy (*Engraulis mordax*), Sacramento splittail (*Pogonichthys macrolepidotus*), and chinook salmon, and exotic species such as striped bass, American shad (*Alosa sapidissima*), and sunfishes. Some of these species are resident fish that remain in the bay throughout all or most of their life cycle; others use the bay simply as a migration corridor. Delta smelt and longfin smelt are considered resident species. Longfin smelt are the most abundant native pelagic fish in Suisun Bay (Herbold and others 1992). Longfin smelt are relatively small (about 13 centimeters in length), open-water fishes that can tolerate a wide range of salinities (Moyle 1976). They are most abundant in areas where salinities often exceed 10 parts per thousand (ppt) (Moyle 1976), and their seasonal distribution is influenced by delta outflow and resulting salinities (Stevens and Miller 1983).

Migratory pelagic species in Suisun Bay include Chinook salmon and striped bass. In general, most anadromous species migrate relatively rapidly through the bay, and do not feed extensively during migration. Some species (such as striped bass) may remain in the estuarine habitat during juvenile rearing.

Fish surveys were conducted in waterways within the Litigation Area during the 1995 to 1996 field effort for the QEA (PRC 1997b). The survey focused on fish in the main slough and the tidal pond in RASS 3. A total of 11 species representing 10 families were identified during the survey. A complete list of fish

species observed or potentially present offshore and in the tidal sloughs is provided in Appendix L in the QEA (PRC 1997b). Of the 375 individuals captured, 78 percent represented just four species. Abundance and distribution of these four species are discussed below. The two most abundant and widespread species, threespine stickleback and prickly sculpin, were selected for tissue collection in 1996. The following table summarizes the relative abundance of each species as well as the number of locations where each species was collected.

ABUNDANCE AND DISTRIBUTION OF FISH SPECIES COLLECTED DURING 1995 TO 1996 FOR THE QEA (PRC 1997b)

Common Name	Latin Name	Total Number Caught	Total Number Of Locations
Threespine stickleback	*Gasterosteus aculeatus*	> 200	6
Mosquitofish*	*Gambusia affinis*	66	1 (pond only)
Prickly sculpin	*Cottus asper*	52	11
Yellowfin goby*	*Acanthogobius flavimanus*	21	6
Shimofuri goby*	*Tridentiger bifasciatus*	19	5
Rainwater killifish*	*Lucania parva*	6	1 (pond only)
Inland silverside*	*Menidia beryllina*	4	3
Sacramento sucker	*Catostomus occidentalis*	2	1
Delta smelt	*Hypomesus transpacificus*	2	1
Tule perch	*Hysterocarpus traski*	2	1
Chinook salmon	*Oncorhynchus tshawytscha*	1	1

Note:

* Not native to Suisun Bay (based on Moyle 1976)

The threespine stickleback was by far the most abundant species caught (53 percent), and the second most widely distributed. The prickly sculpin was the most widely distributed species collected, and the most numerically abundant in the sloughs. Sculpin ranged in total length from 30 to 85 millimeters (mm), suggesting that several year classes are present at the site. Other fairly widely distributed species include two gobies, neither of which is native to California. The yellowfin goby, an Asian native, appeared in the Sacramento-San Joaquin Delta around 1963 (Moyle 1976), and has since become established in fresh coastal waters throughout California. The Shimofuri goby, a more recent arrival from Asian estuaries to Suisun Bay, is thought to have first appeared in 1985. It is quickly becoming the most numerically dominant species in some areas of Suisun Bay (Mattern and Fleming 1994). The mosquitofish was abundant throughout the pond in RASS 3, but was not observed or captured at all in the sloughs. This nonnative species has been widely distributed by agencies responsible for mosquito control as consumers

of aquatic mosquito larvae. The mosquitofish has limited tolerance to saline conditions, so it is expected to remain restricted to areas distant from the influence of Suisun Bay. The nonnative rainwater killifish was captured only in the pond, and in small numbers**.** Four inland silversides were captured in two slough locations and in the pond. Two individual Sacramento suckers were captured in one location, a blind arm of the main slough in RASS 1. This species has been in decline in Suisun Marsh over the past decade. Two tule perch were captured from a single location in the slough.

A single fall-run Chinook salmon parr (juvenile), 50 mm in total length, was captured by seine in the main slough of RASS 1. Mattern and others (1994) have not captured a Chinook salmon since 1989, and caught only one per year during the three years since 1986. Populations of fall-run Chinook are thought to be secure in the Sacramento-San Joaquin drainage (Moyle and others 1995), but the capture of this individual in the slough indicates that the endangered winter-run Chinook may also use the tidal marsh at the Litigation Area (Fisher 1992).

5.1.2 Aquatic Invertebrate Communities

Typical macroinvertebrate species of Suisun Bay include clams (*Corbicula fluminea*), *Corophium* amphipods (*C. stimpsoni* and *C. spinicorne*), bay shrimp, and annelids (Hymanson and others 1994). Historically, dozens of introduced, or exotic, invertebrate species have altered the native invertebrate communities of the San Francisco Bay Estuary. *Potamocorbula amurensis* is an exotic mollusk first detected in Suisun Bay in 1986; it is believed to have been introduced into San Francisco Bay through the release of seawater ballast in the mid-1980s. *P. amurensis* is a suspension feeder that feeds on phytoplankton and zooplankton (Peterson 1996) and is widely distributed on shoals and channel sites in Suisun Bay (Herbold and others 1992). In recent years, the clam has become the most abundant benthic invertebrate in Suisun Bay (Hymanson and others 1994), with densities as high as 45,000 organisms per square meter (Peterson 1996). Although this introduced clam competes with native phytoplankton and zooplankton species in Suisun Bay, it also provides a new food source for bottom feeding birds, fish, and crabs (Carlton and others 1990; Hymanson and others 1994). In addition to *P. amurensis*, other introduced invertebrates include crustaceans such as *Hemileucon hinumensis*, *Gammurus daiberi*, and the crayfish *Pacifasticus lenvisculus*; annelids such as *Streblospio benedicti*; and other clams (Hymanson and others 1994). Native invertebrates that may inhabit Suisun Bay include bay mussels (*Mytilus edulis*), bent-nosed clams (*Macoma nasuta*), *Corophium* amphipods, *Crangon* shrimp, and oligochaete worms such as *Limnodrilus hoffmeisteri* (Hymanson and others 1994).

Benthic invertebrate communities in the tidal wetland (ditches and slough), RASS 3 pond, and RASS 4 wetland were characterized as part of a survey conducted in 1995. Detailed descriptions of the benthic characterization, including quality assurance and quality control discussions and summary tables, are included in the year 1 monitoring report (PRC 1996b, Appendix A). A total of 30 families, 27 orders, and 9 classes of benthic invertebrates were identified in samples collected from 34 locations. Dominant macrofauna in ditches and sloughs included *C. spinicorne*, gammarid amphipods (*A. confervicolus* and *G. daiberi)*, isopods (*Gnorimosphaeroma* spp.), insects (predominantly chironomid larvae), gastropods (*Assiminea californica* and *Physa* sp.), oligochaetes, and sabellid polychaetes. *Corbicula fluminea* (bivalve) occurred in low numbers and only in the slough. The snail, *Physa* sp., and chironomid larvae were the most common invertebrate taxa in the RASS 3 pond. Dominant taxa in RASS 4 were *Physa* sp., chironomid larvae, and other dipterans. No amphipods were collected from RASSs 3 or 4. Oligochaetes comprised 50.9 percent of all taxa observed. Evenness (a measure quantifying the equality of relative abundances of all species in a sample) and species diversity were similar among habitats.

5.1.3 Special Status Species

The only state or federally protected threatened or endangered fish species known to occur in the open water habitat of Suisun Bay and in the tidal sloughs at the Litigation Area are the winter-run Chinook salmon and the delta smelt. Each of these species is briefly described below.

Chinook salmon that occur in the Sacramento-San Joaquin River drainage are distinguished by the timing of their upstream adult migration through the estuary: winter, spring, fall, and late-fall runs. All runs of Chinook salmon use Suisun Bay primarily as a migration corridor during upstream adult migration and downstream juvenile migration. Abundances of all four runs have been declining in recent years, but the winter migration is the only run to receive federal protection thus far. Winter-run salmon comprise less than 5 percent of the adult Chinook salmon returning to the Sacramento-San Joaquin Basin. Adult winter-run salmon migrate from the ocean upstream through Suisun Bay between November and May. No indication exists that the adults feed in Suisun Bay. During both upstream and downstream migration, winter-run salmon are believed to migrate rapidly through the delta and San Francisco Bay (Hallock and Fisher 1985; California Department of Fish and Game [CDFG] 1987; Brown and Greene 1992). Because of differences in the timing of the adult upstream migrations and differences in juvenile rearing habits of the various runs, at least one run of Chinook salmon, including the potential for the federally protected winter run, is probably passing through Suisun Bay during all months of the year.

The Delta smelt is a small, pelagic, plankton-feeding resident of the San Francisco estuary. Individuals are generally less than 80 mm in length, but occasionally reach lengths of about 120 mm (Moyle 1976). Prespawning adults are found in Suisun Bay or the western delta as early as September (California Department of Water Resources and California Department of Water Resources and U.S. Bureau of Reclamation 1994). Currently, the delta smelt is classified at the federal and state levels as threatened. During the fish surveys, two individuals were captured in the main slough in RASS 1. The two individuals were released after they were identified, and appropriate state and federal resource trustees were notified.

Delta smelt are often located in proximity to the entrapment zone (an ecologically important region of the estuary characterized by high levels of suspended particulates, turbidity, and densities of several types of organisms), since they generally inhabit a salinity range of less than 2 ppt (Moyle and others 1992). During periods of high delta outflow, transient populations of delta smelt occur downstream in San Pablo Bay. Juvenile and adult delta smelt commonly occur in the surface and shoal waters of the Sacramento River below Isleton, in the San Joaquin River below Mossdale, throughout the delta, and in Suisun Bay (Moyle 1976; Moyle and others 1992). Delta smelt generally have a 1-year life span and typically die after spawning (Moyle 1976).

Delta smelt spawn in fresh or slightly brackish water upstream of the entrapment zone (Wang 1991). During spawning, the eggs sink to the bottom, where they adhere to any available hard substrate (Moyle 1976; Wang 1991). Newly hatched larvae drift downstream to the upper end of the entrapment zone (Wang 1991; Moyle and others 1992). The larvae begin feeding on zooplankton about 4 to 5 days after hatching. Larval delta smelt metamorphose into the juvenile stage at approximately 25 mm in length (Wang 1991). Spawning locations vary from year to year (Sweetnam 1996). In years of moderate to high delta outflow, spawning typically occurs from sloughs of Suisun Marsh upstream to the Sacramento and San Joaquin rivers (Wang 1991). In years of low delta outflow, spawning occurs upstream in various portions of the delta and Sacramento River.

Recent declines in the delta smelt population have been attributed to a general movement of the entrapment zone from the relatively productive waters of Suisun Bay to the less productive waters of the western delta as a result of reduced freshwater outflow and increased water diversions (Moyle and others 1995). However, according to Mattern and others (1994), this species has become somewhat more abundant since its near absence from their surveys in the mid-1980s.

5.2 EXPOSURE AND EFFECTS ASSESSMENT FOR FISH AND AQUATIC INVERTEBRATES

Exposure is typically defined by the cooccurrence or contact of a stressor in both time and space with a receptor of interest. The exposure assessment for organic COPECs was based on the distribution of total DDTs and PCBs and Aroclors in sediment and the calculation of sediment:tissue BAFs. Exposure of fish and aquatic invertebrates to inorganic COPECs was assessed by evaluating the distribution of metals in surface water and sediment and by indicators of exposure, including concentrations of metals in tissues and the calculation of sediment:tissue BAFs. Metal concentrations in sediment pore water and extracts provided additional evidence of exposure potential.

As an initial step during the exposure assessment, plausible exposure scenarios for fish and aquatic invertebrate receptors were considered, and the appropriate spatial scale for defining exposure units was identified. The focus of the 5 years of monitoring at the Litigation Area was on changes in contaminant concentrations at the scale of an individual spatial unit or across an entire RASS. The boundaries separating spatial units are arbitrary with respect to the natural ranges of ecological receptors; therefore, for the BERA it was necessary to define exposure units that more closely reflect the habitat areas used by receptors. Individual sampling locations were grouped into seven aquatic exposure units or habitat areas: (1) main slough, (2) slough reference area, (3) ditches, (4) Nichols Creek, (5) Nichols Creek upland reference area, (6) RASS 3 pond, and (7) RASS 4 wetland. Reference areas were defined in Section 3.4.

Assessment of ecological effects resulting from exposure to COPECs was accomplished using direct measures of toxicity (bioassays) and by comparing chemical concentrations in sediment and soil, surface water (inorganic COPECs only), and tissue with appropriate toxicological benchmarks. Sediment benchmarks were the ER-L, ER-M, and ER-M quotient (ER-M_q). Surface water benchmarks were acute and chronic AWQC (Tables 10A and 10B). No accepted benchmarks exist for assessing the ecological significance of sediment:tissue BAFs; for this BERA, a BAF of 1.0 was used as a general guideline.

The exposure and effects assessments for organic and inorganic COPECs are discussed in Sections 5.2.1 and 5.2.2.

5.2.1 Organic Chemicals of Potential Ecological Concern

Sections 2.2.1 and 3.1 present background information and summarize available data on organic chemicals at the Litigation Area. As discussed in Section 2.2, regulatory agency concerns that risk from organic contaminants was not adequately addressed in the QEA (PRC 1997b) prompted a reevaluation of

existing data from the QEA to specifically address uncertainty associated with the low frequency of detection and high DLs from this study. The decision to restrict the reevaluation to total concentrations of DDTs and PCBs in soil and sediment was based on discussions between the Navy and regulatory agencies held on August 8, 2000, as well as on an EPA proposal submitted to the Navy. The proposal outlined EPA's concerns and potential options for conducting the reevaluation. A counter proposal for the reevaluation of total DDTs and PCBs was subsequently prepared by the Navy, and details of the Navy's proposal were presented and discussed at a meeting held on March 5, 2001. The approach for reevaluating organic chemicals described in this section reflects agreements between the Navy and regulatory agencies reached at the March 5 meeting. The reevaluation was conducted separately for fish and aquatic invertebrates, as well as for birds and mammals, using appropriate exposure scenarios for each group. Details of the approach used for birds and mammals are presented in Section 6.0. The reevaluation of existing data on organic contaminants included a sensitivity analysis to determine the effect of estimating total concentrations of DDTs and PCBs based on substituting either one-half the DL or the full DL for all ND analytes. Substitution of the full DL for all ND congeners represents a worst-case scenario, and total concentrations of DDTs and PCBs calculated in this manner represent the maximum possible contaminant concentrations. When data are characterized as ND, the "true" concentration falls along a distribution of possible concentrations ranging from zero to the reported DL. This approach, therefore, may greatly overestimate true concentrations of multiple-constituent compounds like DDTs and PCBs. Substituting one-half DL for ND data probably represents a more realistic scenario.

More than 100 locations were sampled for organic chemicals in the QEA (PRC 1997b) (Figure 13). At most locations, surface (0 to 0.5 foot bgs) and subsurface (0.5 to 1.5 feet bgs) samples were collected. For the reevaluation, only the sample containing the highest concentration of total DDTs or PCBs at each location was used in the preparation of data summaries. Details of the summing procedure were described in Section 3.0. Table 58 summarizes total DDT and PCB concentrations for all habitat areas at the Litigation Area. Summary statistics in Table 58 are provided for all locations pooled within each habitat area and include both detected and ND data. Since the data summaries were prepared using only the higher of the surface and subsurface samples, the detection frequencies reported in this table do not reflect the total number of samples in which at least one DDT isomer or PCB compound was detected. All detected data are summarized in Table 59. Table 59 provides summary statistics for total DDTs and PCBs that include all samples at each location within each of the individual habitat areas. Total concentrations of DDTs and PCBs (low-level CLP method) at individual sampling locations within each habitat area are presented in Table 60. Total concentrations of Aroclors at individual sampling locations

are presented in Table 62. A summary of the reported DLs for individual DDT and PCB congeners or compounds reported using both the modified low-level and regular CLP methods is provided in Table 61.

The distribution of DDTs across the Litigation Area generally reflects low levels of residual contamination resulting from the legal application of DDTs for mosquito control from the 1940s until 1972, when DDTs were banned. DDTs were only detected in the slough (five samples at three locations), RASS 3 pond (two samples at one location), and the RASS 4 wetland (seven samples at six locations). The highest detected concentration of total DDT (329 microgram per kilogram [µg/kg]) was detected in a single sample from the RASS 4 wetland. The remaining detected concentrations of total DDTs were all below 41 µg/kg. Except for the single sample from the RASS 4 wetland, only samples from the slough (72 µg/kg) and ditches (84 µg/kg) contained worst-case concentrations that exceed the ER-M for sediment. Maximum (worst-case) concentrations of total DDTs at 23 sampling locations in the ditches ranged from 45 to 84 µg/kg; however, because no concentrations of DDTs were detected in samples from the ditches, these concentrations are estimated using reported DLs only.

The distribution of PCBs also reflects a pattern of low-level residual contamination, although no known sources of PCBs occur at the site. The railroads that run through the Litigation Area are the only suspected sources of PCB contamination. Detected concentrations of total Aroclors were only reported for the slough (one sample at one location) and RASS 4 wetland (one sample at one location), with maximum detected concentrations of 210 and 45 µg/kg, respectively. For the aquatic habitats, the highest worst-case concentrations of total Aroclors were reported from the ditches (2,240 µg/kg) and slough (1,760 µg/kg). Concentrations of total Aroclors in the ditches were fairly uniform, and worst-case concentrations based on ND data exceeded 1,000 µg/kg at all locations. A similar pattern was shown in the slough, with worst-case concentrations exceeding 500 µg/kg at all locations (Figure 80).

A key part of the reevaluation of data for organic contaminants requested by the regulatory agencies was a location-by-location comparison across the Litigation Area of the risk posed by organic versus inorganic contaminants. Additionally, the agencies requested an analysis that considered the spatial distribution of total DDTs and PCBs as well as an identification of areas where high concentrations of either organic contaminant were detected, but where risk from metal contamination was generally below a level of concern. As explained in Section 3.0, the majority of samples collected for PCBs were analyzed using regular CLP methods; therefore, the evaluation for total PCBs is based on total Aroclors, where total Aroclors were calculated by summing the concentrations for seven individual PCB mixtures.

The reevaluation was accomplished by comparing plots of bulk sediment concentrations of total DDTs and Aroclors at each location with plots of the maximum mean ER-M_q for six metals calculated for the same locations (Figures 79 and 80). Locations are identified in both plots according to decreasing worst-case concentrations of each organic analyte. Dashed lines show concentrations obtained by substituting the full DL for ND compounds, while solid lines show total concentrations based on one-half of the DL for NDs. Concentrations of total DDTs and Aroclors calculated using detected data only are shown in parentheses to the left of the location identification labels on Figures 79 and 80. The mean ER-M_q was used as a surrogate measure of risk from inorganic contaminants that takes into account the additive effect of exposure to mixtures of chemicals. The maximum mean ER-M_q at each location is the maximum value calculated from each of the 5 years of monitoring. Additional discussion of the derivation and interpretation of effects thresholds based on the mean ER-M_q is provided in Section 5.2.2.

For the second part of this analysis, threshold values were defined for total DDTs, Aroclors, and the maximum mean ER-M_q. Locations where concentrations of either total DDTs or Aroclors exceeded the defined threshold and where values for the maximum mean ER-M_q were less than its respective threshold are shown on Figure 81. For total DDTs, the threshold selected was the exceeded ER-M benchmark for total DDTs in sediment. Because no toxicity benchmark exists for ecological receptors based on Aroclors, the threshold for total Aroclors was defined as the 67th percentile (nonparametric) of the total Aroclor concentrations at all locations across the Litigation Area. The threshold concentration for total Aroclors is 1,178 µg/kg. The threshold for Aroclors, therefore, defines the upper one-third of concentrations from the sitewide distribution of total Aroclors. The threshold for total Aroclors is not intended to represent a toxicity benchmark. It is only used to define the population of Litigation Area locations that exhibit the highest relative concentrations of PCB mixtures. The full DL was used for ND mixtures in calculating the total Aroclor concentrations used to define the distribution. A threshold value of 0.50 was chosen for the maximum mean ER-M_q for metals based on Long and MacDonald (1998). Additional discussion of the derivation and significance of this threshold for the ER-M_q is provided in Section 5.2.2. Locations where any detected DDT isomers or PCB mixtures were reported are shown on Figure 81. Threshold values for organic analytes and the maximum mean ER-M_q have also been indicated on each of the plots on Figures 79 and 80.

As shown on Figure 79, total worst-case concentrations of DDTs exceed the ER-M in all but one location in the ditches; however, no isomers of DDT were detected in any samples from any ditch locations, so these estimates reflect analytical DLs rather than actual concentrations. If one-half of the DL is substituted for NDs in estimating total DDTs, concentrations are below the ER-M at all locations. Worst-case concentrations of total DDTs exceeded the ER-M at only three locations in the main slough, but no

locations exceeded the benchmark when total concentrations were estimated using one-half the DL for ND analytes. The RASS 4 wetland is the only area where detected concentrations of DDTs exceeded the ER-M. A concentration of 329 µg/kg was measured at location R04WD212. At least one DDT isomer was detected at all six locations within the RASS 4 wetland, but no additional exceeded ER-Ms were reported, even when the full DL was substituted for NDs in the calculation of total DDTs.

A similar pattern of widespread but low-level contamination with PCBs is shown on Figure 80. All 23 ditch locations show worst-case concentrations of total Aroclors that exceed the 67th percentile threshold of 1,178 µg/kg. However, no PCB mixtures were detected in any samples from any ditch location. Only 3 of 26 locations in the main slough have worst-case concentrations of total Aroclors that exceed the threshold; none of these concentrations were based on detected concentrations of PCBs. PCBs were detected at a single location in the main slough (R01SH050), with a reported total Aroclor concentration of 210 µg/kg. No PCB mixtures were detected in the RASS 3 pond, and all worst-case estimates of total Aroclors were below the threshold. PCBs were detected at a single location in the RASS 4 wetland (location R04WD199, 45 µg/kg), but worst-case concentrations of total Aroclors did not exceed the threshold at any location in this habitat.

Figure 81 shows the location of all detected concentrations of total DDTs and Aroclors as well as the locations where worst-case concentrations of these organic analytes exceed threshold values, but where risk from metals is generally considered to be below a level of concern. One of 23 ditch locations, 2 of 26 locations in Lost Slough, and 1 of 22 locations on the marsh surface met this criterion. No locations in the RASS 3 pond or RASS 4 wetland met the criterion for either DDTs or PCBs. None of the four locations identified had detected concentrations of any DDT isomers or PCB mixtures; therefore, the reported worst-case concentrations are estimates based on ND data.

Concentrations of the 2,4' and 4,4' isomers of DDD, DDE, and DDT in the tissue of fish (stickleback and sculpin), tadpole, clam, crayfish, and damselfly larvae were reported in the QEA (PRC 1997b). The highest tissue concentrations reported in the QEA for 4,4'-DDT were in sculpin and stickleback samples from Lost Slough and the RASS 3 pond, respectively. BAFs for 4,4'-DDT in fish tissue ranged from 5.9 to 7.7. Concentrations of the 2,4' isomers were low or not detected in most samples (PRC 1997b). Results of PCB congener analysis for clam, crayfish, and damselfly tissue were also provided in the QEA. Few detections were reported for PCB congeners, and all detected concentrations were only slightly higher than the reported detection limits. Calculations of sediment:tissue BAFs for PCBs were not provided in the QEA.

5.2.2 Inorganic Chemicals of Potential Ecological Concern

The exposure and effects assessment for inorganic chemicals is based on 5 years of monitoring data and additional data collected during October 2000. Additional evidence of exposure potential is provided by direct measurement of metals in tissue, through the calculation of BAFs for collocated tissue and sediment samples, and from concentrations of metals in pore water and sediment extracts. The exposure and effects assessments for contaminated sediment and surface water are discussed in Sections 5.2.2.1 and 5.2.2.2, respectively.

5.2.2.1 Sediment

Sediment concentrations consistently exceed the ER-M at numerous locations across the site. Summaries of sediment metal concentrations for each aquatic habitat area from the 5 years of monitoring and the October 2000 sampling event are presented in Attachment G1 and Figure 75. Maps showing the spatial and temporal relationships among metal concentrations at individual locations are provided on Figures 22 through 33. Tables 55 and 56 provide sediment concentrations for the complete suite of 20 metals and miscellaneous sediment parameters from the October 2000 sampling event. Results of a screening assessment for sediment metals from October 2000 are provided in Table 55. Sediment pore water and WET-DI test results from the QEA (PRC 1997b) are provided in Tables 72 and 73, respectively. Metal concentrations in clam tissue and collocated sediment samples and the calculation of BAFs for the combined QEA and October 2000 data are provided in Tables 74 and 75. Data for metal concentrations in fish and other vertebrate and aquatic invertebrate tissues are summarized in Table 76.

Additional information on exposure potential is based on tissue burdens of metals in animals and on concentrations of metals in sediment pore water and WET-DI extracts. With the exception of lead, sediment:clam BAFs were greater than 1.0 in at least one location (Table 74). For the other metals, sediment:clam BAFs greater than 1.0 were reported for antimony, beryllium, mercury, molybdenum, silver, and thallium in samples from at least one location (Table 75). With the exception of mercury (maximum BAF of 14.3) and selenium (BAF of 4.8) in stickleback tissue, sediment:tissue BAFs were less than 1.0 for fish, tadpoles, amphipods, crayfish, and damselfly nymphs for all COPECs (Table 76).

Sediment pore water and WET-DI extracts contained extremely low concentrations of metals relative to concentrations in bulk sediment. Less than 0.27 percent of the metal concentrations in bulk sediment was measured in pore water for each of the six COPECs (Table 73). The percentages were slightly higher for WET-DI extracts, with concentrations for some metals in extracts exceeding 1 to 5 percent of concentrations in bulk sediment (Table 72). Maximum concentrations in extracts exceeded 1.0 percent of

bulk sediment concentrations for arsenic (1.59 percent), cadmium (3.8 percent), copper (1.89 percent), lead (3.56 percent), mercury (1.90 percent), and zinc (5.12 percent).

TtEMI also compared metals concentrations in pore water with acute and chronic surface water quality criteria for dissolved and total metals in Tables 10A and 10B. Results of this comparison are summarized in the table below. The values in this table represent the number of samples (out of 10) with concentrations exceeding the respective criterion.

Metal	Dissolved Metal Criteria		Total Metal Criteria	
	Acute	Chronic	Acute	Chronic
Arsenic	0	3	2	3
Cadmium	0	0	0	0
Copper	0	5	4	4
Lead	0	2	0	2
Mercury	0	7	0	7
Selenium	0	0	0	0
Zinc	0	3	3	3

Lines of evidence indicating potential effects on fish and aquatic invertebrates from exposure to contaminated sediment include:

1. Percent of successful hatchings of topsmelt embryos in 12-day sediment-water interface bioassays
2. Survival of *Eohaustorius estuarius* in 10-day whole sediment bioassays
3. Survival and growth of *Hyalella azteca* in 14-day whole sediment bioassays
4. Concentrations of metals in aquatic biota and calculation of BAFs for collocated tissue and sediment samples
5. Comparison of bulk sediment metal concentrations with ER-L and ER-M toxicity benchmarks
6. Calculation of the mean ER-M_q and comparison of the mean ER-M_q with literature-derived effects levels

Supplemental evidence of potential risk that supports the interpretation of bioassay results includes the following:

1. Calculation of SEM-AVS

2. Concentrations of metals in sediment porewater and WET-DI extracts

3. Analysis of miscellaneous chemical and physical parameters that affect metal bioavailability

The draft final work plan for the five-year assessment report (TtEMI 2000e) listed benthic community metrics as an additional line of evidence. The Navy proposed to reanalyze data for benthic invertebrates collected during the first year of postremediation monitoring (PRC 1996b) using an approach developed for the Benthic Pilot Study by the San Francisco Estuary Institute (SFEI) (SFEI 2000). The SFEI metrics were not, however, suitable for evaluating benthic community data collected at the Litigation Area. Very few specimens collected at the Litigation Area data were identified to species, and few of the indicator species on which SFEI community metrics are based occur at the site. Further analysis of these data is unlikely to provide defensible support to the BERA.

An overview of the sources and general description of the data used to support the effects assessment for fish and aquatic invertebrates was provided in Section 3.0. The remainder of this section summarizes the relevant findings and main conclusions for each of the lines of evidence listed previously. Supplemental information that supports the effects assessment or aids in the interpretation of results from the bioassays is provided in Section 5.3.

Direct Measures of Toxicity from Sediment Bioassays

Toxicity in the topsmelt and *Hyalella* tests was defined by comparing the response for each test endpoint with the laboratory controls. Test results less than 80 percent of the control response exceed the threshold level of concern, as shown in Table 54. For the *Eohaustorius* bioassays, toxicity was defined by comparison of site survival with the RWQCB reference envelope edge (RWQCB 1998a). The reference envelope edge for *Eohaustorius* is 68 percent survival, which represents the 95th percent lower confidence interval of the 8th percentile for survival based on a suite of baywide locations evaluated by RWQCB (1998a). Because the RWQCB has not defined a reference envelope for *Hyalella,* a reference area was established in the main slough to provide a site-specific point of comparison for this test. Eighty percent survival for *Hyalella* at the reference locations was the criterion established for defining acceptability of the reference site (Table 55).

Topsmelt 12-day Sediment-Water Interface Tests

Topsmelt bioassays were conducted using sediment collected from eight locations in the main slough and two locations from the RASS 3 pond in 1998. Percent hatch at all 10 locations was greater than 80 percent of the control (Table 54).

A graphical comparison of the topsmelt bioassay results and bulk chemistry results is presented on Figure 85. Correlations of percent successful hatch with sediment chemistry parameters were mostly nonsignificant (Table 79). An exception to this is a significant negative correlation between percent hatch and copper (r equals -0.64, p equals 0.046). Additional discussion of the relationship between sediment chemistry and toxicity for all bioassays conducted at the Litigation Area is provided in Section 5.3.

The topsmelt test does not indicate toxicity in sediment collected from the main slough or RASS 3 pond. Sediment used in the topsmelt tests, however, did not reflect the highest concentrations of metals at the Litigation Area, resulting in some uncertainty about the potential effect of the highest concentrations on topsmelt (Section 7.6).

Eohaustorius 10-day Whole-Sediment Tests

Ten-day whole-sediment toxicity tests using the amphipod *Eohaustorius estuarius* were conducted at 23 locations in 1995 and at 7 locations in 2000 (Tables 80 and 81). The 1995 samples were collected from the marsh surface (six locations), marsh reference area (three locations), main slough (eight locations), RASS 1 ditches (three locations), RASS 3 pond (two locations), and the RASS 4 wetland (one location). In 2000, samples were collected from the main slough (four locations) and the RASS 1 ditches (three locations). Although both percent survival and percent reburial were measured, only the survival endpoint has a RWQCB reference envelope edge threshold.

One sample from the marsh reference area (MHRSS005, 67 percent survival) in 1995 had survival less than the RWQCB reference envelope edge of 68 percent (Table 80). The range for control survival in 1995 was 95 to 100 percent. In 2000, survival in one sample from the western arm of Lost Slough (R01SH305, 62 percent survival) was less than the reference envelope edge (Table 81). The mean survival for the control in 2000 was 96 percent, and the range for the ditch and slough locations was 81 to 86 percent and 62 to 81 percent.

Locations where survival was less than the reference envelope edge are noted with an asterisk on Figure 85, a graphical comparison of *Eohaustorius* survival in 1995 and 2000 with bulk chemistry results. Correlations between percent survival from the 1995 test and sediment chemistry parameters were not

significant (Table 82). A weak positive correlation between reburial measured in 1995 and pH was shown (r equals 0.45, p equals 0.04). In tests conducted in 2000, percent survival was positively correlated with total sulfide concentration in sediment (r equals 0.85, p equals 0.01). No other correlation between bioassay endpoints and sediment chemistry was noteworthy. Survival or reburial and chemical concentrations in pore water and sediment extracts showed no significant correlation (Table 83).

Eohaustorius tests show that soil and sediment from isolated areas of the Litigation Area may cause some adverse effects in aquatic invertebrates; however, the magnitude of observed effects was low. The decision criterion in the WOE table (Table 54) for this test is only based on survival. The Navy considered including nonreburial in a separate measure of "effective survival," as suggested by the regulatory agencies, but elected to report separate results for survival and nonreburial because of the lack of an accepted toxicity threshold for "effective survival." Eleven out of 23 locations sampled in 1995 reported percent survival that was statistically lower than laboratory controls. None of the seven locations sampled in 2000 reported reburial that was statistically lower than laboratory controls.

The lack of correlation between toxicity test results and bulk sediment chemistry is typical of tests conducted in the San Francisco Bay area and elsewhere (SFEI 1999; Long and others 1995). The lack of either significant correlations or concentration-response relationships in these tests is generally attributed to the difference between bulk sediment concentrations and bioavailable fractions of chemicals in sediment.

Hyalella 14-day Whole-Sediment Test

Fourteen-day whole sediment bioassays were conducted at 13 locations (three in RASS 1 ditches, seven in the main slough, and three in the slough reference area) in October 2000 (Table 84). Two slough locations reported survival less than 80 percent of the control (66 percent as the threshold); the magnitude of concentrations exceeding the threshold was low (R01SH131 had 57.5 percent survival and R01SH307 had 47.5 percent survival).

The acceptance criterion of 80 percent survival was met at two of the three slough reference locations sampled during October 2000 (Table 84). *Hyalella* survival was 70 (location SLRSH01), 82.5 (location SLRSH02), and 81.2 (SLRSH03) percent at the reference locations. Some metals concentrations detected at these locations exceeded Concord Tidal Area and San Francisco Bay ambient concentrations, but none except nickel exceeded the ER-M. The ER-L for arsenic, chromium, copper, mercury, and zinc was exceeded at one or more slough reference locations.

Correlations of percent survival and growth with sediment chemistry parameters are presented in Table 85 and Figure 85. Neither percent survival nor growth was significantly correlated with sediment chemistry. pH was negatively correlated with the concentrations of several chemicals, including arsenic (r equals -0.59, p equals 0.03), cadmium (r equals -0.79, p equals 0.001), copper (r equals -0.59, p equals 0.03), selenium (r equals -0.76, p equals 0.003), and zinc (r equals -0.79, p equals 0.001), suggesting that higher concentrations of each of these metals tend to be associated with lower soil or sediment pH (Table 85). Concentrations of AVS showed a strong positive correlation with zinc (r equals 0.88, p equals 0.001), and slightly weaker correlations with cadmium (r equals 0.68, p equals 0.01) and lead (r equals 0.56, p equals 0.04). This finding could reflect the ability of AVS to bind metals and, in some cases, fix them in place, thereby reducing their mobility. Additional discussion of the relationship between sediment chemistry and toxicity findings for all bioassays conducted at the Litigation Area is provided in Section 5.3.

Results from the two amphipod toxicity tests showed that effects of sediment on benthic invertebrates are probably limited to isolated areas of the site. The poor correlation between effects endpoints in toxicity tests and sediment chemistry is likely caused by the lack of association between bulk chemistry results and bioavailability of chemicals and limits the interpretation of the causal element in the observed toxicity. Additional discussion of the role of bioavailability in explaining the pattern of toxicity to *Hyalella* is provided in Section 5.3.

Overview of Bulk Sediment Chemistry Data and Comparison of Metal Concentrations with Effects Benchmarks

Detailed descriptions and summaries of the distributions, relative concentrations, and potential risk posed by each of the six metal COPECs are presented below.

Sitewide distribution of COPECs in sediment or soil for monitoring years 1 through 5 and comparison of metal concentrations with the ER-L and ER-M benchmarks are provided on Figures 22 through 33. Attachment G1 provides raw data, outlier box-plots, and summary statistics for each habitat. The box plots in Attachment G1 also show bright-lines corresponding to the ER-L and ER-M as well as the grand mean of metal concentrations across all locations or sampling rounds. An additional summary of metal concentrations based on areawide averages calculated for monitoring years 1 through 5 is provided in Table 77. Areawide averages in Table 77 were calculated by averaging the 5-year means at individual locations for each metal within each habitat. Table 77 also compares the UCL_{95} of the areawide average for each metal with the ER-M. Figure 82 shows the percentage of locations within individual habitat

areas that exceed the ER-L and ER-M benchmarks for each of the six metals from the 5 years of monitoring.

Summaries of the distribution and relative concentrations of individual metal COPECs in sediment and comparison with sediment benchmarks are provided below.

Arsenic in Sediment

The highest concentrations of arsenic are in the southeastern portion of RASS 1, with many ditch locations in Unit 7 consistently exceeding four times the ER-M (70 mg/kg) during the 5 years of monitoring (Attachment G1, Figures 22 and 23). Similar concentrations were detected in sediment and soil on the marsh surface in many adjacent locations in Unit 6. Arsenic concentrations in Nichols Creek are generally below the ER-L at all locations. Concentrations of arsenic in the RASS 3 pond are mostly below the ER-L or between the ER-L and ER-M. Concentrations at most locations along the main slough exceed the ER-L but are less than the ER-M. Concentrations in the RASS 4 wetland are mostly below the ER-L or between the ER-L and ER-M. The main slough was the only aquatic habitat where the UCL_{95} (79.1 mg/kg) based on the 5-year, areawide average concentration of arsenic exceeded the ER-M (Table 77).

Cadmium in Sediment

High concentrations of cadmium are detected sporadically in sediment across the site (Attachment G1 and Figures 24 and 25). Concentrations greater than four times the ER-M (9.6 mg/kg) were detected at several locations in Units 10 and 11 along the main slough and western arm of the slough and in the southeastern portion of RASS 1 along the ditches in Unit 7. Concentrations along Nichols Creek are generally less than the ER-L or between the ER-L and ER-M. Concentrations in the RASS 3 pond are below the ER-L or between the ER-L and ER-M; concentrations that exceed the ER-M were detected at a few locations during some sampling rounds. Concentrations in the RASS 4 wetland are generally below the ER-L. The UCL_{95}s based on the 5-year, areawide concentrations of cadmium exceeded the ER-M in the ditches (10.6 mg/kg), main slough (20.4 mg/kg), and the RASS 3 pond (10.0 mg/kg) (Table 77).

Copper in Sediment

The highest concentrations of copper are detected in the southeastern portion of RASS 1 along the ditches in Units 6 and 7 (Attachment G1 and Figures 26 and 27). Concentrations at a number of ditch locations exceed four times the ER-M (270 mg/kg). Concentrations in the main and the western arm of the slough and in the RASS 3 pond are mostly between the ER-L and ER-M. Concentrations along most of Nichols

Creek are less than the ER-L. Concentrations in the RASS 4 wetland are mostly between the ER-L and ER-M. The RASS 1 ditches were the only aquatic habitat locations in which the UCL_{95} based on the 5-year, areawide concentration of copper (306 mg/kg) exceeded the ER-M (Table 77).

Lead in Sediment

Lead concentrations are rarely above levels of concern in Litigation Area sediment (Attachment G1 and Figures 28 and 29). Concentrations exceeding the ER-M (218 mg/kg) are detected sporadically at only a few locations in Nichols Creek and the RASS 3 pond. Other locations in the ditches, slough, and RASS 4 wetland are consistently less than the ER-L or between the ER-L and ER-M. The UCL_{95}s based on the 5-year, areawide concentrations of lead did not exceed the ER-M in any of the aquatic habitats at the Litigation Area (Table 77).

Selenium in Sediment

Elevated concentrations of selenium are widespread in sediment at locations across the site (Attachment G1 and Figures 30 and 31). Concentrations of selenium greater than the ER-M (1.4 mg/kg) but less than four times the ER-M are common along most of the main and western arm of the slough and in the southeastern portion of RASS 1 in Units 6 and 7. Concentrations along Nichols Creek are mostly less than the ER-L or between the ER-L and ER-M, with a few locations slightly exceeding the ER-M during some years. Concentrations in the RASS 3 pond are similar to Nichols Creek, although samples from a higher percentage of locations contain concentrations that exceed the ER-M by less than a factor of 2. Concentrations in the RASS 4 wetland generally range between the ER-L up to concentrations less than four times the ER-M, with occasional hits exceeding four times the ER-M. The UCL_{95}s based on the 5-year, areawide concentrations of selenium exceeded the ER-M in the ditches (2.75 mg/kg), main slough (2.04 mg/kg), and the RASS 4 wetland (5.07 mg/kg) (Table 77).

Zinc in Sediment

Elevated concentrations of zinc in sediment are widespread at locations across the Litigation Area (Attachment G1 and Figures 32 and 33). Concentrations exceeding four times the ER-M (410 mg/kg) are common along Lost Slough in Unit 11, along the ditches of Units 6 and 7, in Nichols Creek downstream from CPC property, and in the RASS 3 pond. Zinc concentrations in Nichols Creek upstream from CPC are mostly less than the ER-L. Concentrations of zinc in the RASS 4 wetland are generally less than the ER-L or between the ER-L and ER-M. The UCL_{95}s based on the 5-year, areawide concentrations of zinc

exceeded the ER-M in the ditches (1,468 mg/kg), main slough (2,856 mg/kg), Nichols Creek (2,000 mg/kg), and the RASS 3 pond (3,857 mg/kg) (Table 77).

Calculation of the Mean ER-M_q and Potential Effects of Exposure to Mixtures of Metals

Analyses based on comparisons to single chemicals may not accurately reflect the risk to fish and aquatic invertebrates exposed to mixtures of chemicals. The mean ER-M_q takes into account the additive effect of exposure to chemical mixtures (Long and MacDonald 1998). The mean ER-M_q is calculated by taking the average of the ER-M_qs for individual chemicals. Long and MacDonald (1998) reported that increasing toxicity in laboratory bioassays coincided with the number of ER-M benchmarks exceeded in test sediment. When the mean ER-M_q was greater than 1.0, 50 percent of the ER-Ms (12 of 25 samples) were exceeded, and 71 percent of samples evaluated showed high toxicity. Long and MacDonald (1998) assign sites with a mean ER-M_q greater than 1.5 as highest priority based on potential toxicity. Sites with a mean ER-M_q between 0.51 and 1.5 were classified as medium to high priority sites, and sites with mean ER-M_qs between 0.11 and 0.50 were considered medium to low priority sites.

The ER-Ms are based on sediment toxicity tests using primarily estuarine organisms. In a tidal marsh such as the Litigation Area, no clear demarcation between soil and sediment exists. Estuarine organisms occur throughout most of the Litigation Area at one time or another. Possible exceptions to this are sections of the RASS 3 and RASS 4 upland, which can be safely characterized as soil. In the absence of equivalent measures for soil that integrate risk estimates for multiple chemicals, the mean ER-M_q was calculated for all locations at the Litigation Area, including the upland areas. Professional judgment must be used in interpreting the significance of mean ER-M_q values at locations where estuarine organisms are not the receptors of interest. Location-specific values for the mean ER-M_q for each of the 5 years of monitoring are on Figures 83 and 84. Color codes on the maps indicate the relative values for the mean ER-M_q calculated for each year of sampling at each location. Areas that pose the greatest potential for unacceptable risk to aquatic invertebrates and fish are shown in red (mean ER-M_q greater than 3.0) in Figures 83 and 84. Attachment G3 provides raw data, outlier box-plots, and summary statistics for each habitat.

Distribution of potential risk based on the ER-M_q conforms to patterns for several individual metals (Figures 83 and 84). Mean ER-M_qs in ditches along the southeastern corner of RASS 1 in Units 6 and 7 are consistently greater than 1.5 and often exceed 3.0. Other areas of the site with mean ER-M_qs above threshold values that indicate probable risk are found along Lost Slough, the section of Nichols Creek downstream from the CPC, and in the RASS 3 pond. Selected locations along the main slough contained

elevated mean ER-M_qs for some sampling rounds, with locations in Unit 10 showing the most consisted pattern of contamination. Only one location in the RASS 4 wetland had a mean ER-M_q exceeding 3.0, although elevated values were commonly reported from adjacent soil locations.

5.2.2.2 Surface Water

Lines of evidence indicating potential effects on fish and aquatic invertebrates from exposure to inorganic chemicals in surface water are based on comparison of total and dissolved surface water metal concentrations with acute and chronic water quality benchmarks (Tables 10A and 10B). The two sets of benchmarks (acute and chronic) reflect the lower of the freshwater or marine criteria from EPA (1997a, 1998a, 1998c, 1999) or the California Toxics Rule (Title 40 *Code of Federal Regulations* Part 131). Hardness dependent criteria were calculated using a hardness value of 400 milligrams per liter (mg/L) as calcium carbonate. Additional details concerning the surface water criteria used at the Litigation Area are provided in the footnotes to Tables 10A and 10B.

Concentrations of the six COPECs are elevated above surface water screening criteria listed in Tables 10A and 10B in each of the aquatic habitats at the Litigation Area, raising concern with respect to the potential exposure of fish and aquatic invertebrate receptors. During the 5 years of postremediation monitoring, 485 samples were collected from 134 surface water locations and were analyzed for total metals. Dissolved metals were analyzed in 30 samples from 27 locations collected during monitoring years 4 and 5. All samples collected during the 5 years of postremediation monitoring were analyzed using standard CLP methods. The failure of the standard CLP protocols to achieve DLs lower than water quality benchmarks for COPECs has been the focus of discussion between the Navy and regulatory agencies and is discussed in more detail in the risk characterization and uncertainty analysis in Section 7.0. An additional 10 locations were sampled on two separate days and analyzed for total and dissolved metals using low-level CLP methods during the October 2000 monitoring event.

Summaries of total metal concentrations for the six metal COPECs in surface water from the 5 years of monitoring are provided in Attachment G3 and Figures 38 through 43. Total and dissolved surface water metal concentrations for the suite of 20 metals sampled in October 2000 are presented in Table 57. Areawide averages were calculated by averaging the 5-year means at individual locations for each metal within each habitat. The mean and UCL_{95} of the areawide average for each metal was also compared with the acute and chronic water quality benchmarks (Table 67). Figure 86 shows the number of locations within individual habitat areas where total metal concentrations in surface water exceeded the acute and chronic benchmarks for each of the six metals from the 5 years of monitoring. Data for this summary

were prepared by substituting one-half of the validated result for all ND metals. To account for uncertainty introduced by the low detection frequencies reported for several metals, the number of locations exceeding the benchmarks was also calculated by substituting the full DL for all ND samples. The number of exceeded limits in this case is indicated above the bars for each plot on Figure 86. Figure 87 shows the number of locations within each habitat where dissolved metal concentrations exceeded the acute and chronic water quality benchmarks during monitoring years 4 and 5. As described for Figure 86, the number of locations exceeding the benchmarks when the full reported value is substituted for ND samples is shown above the bars in each of the plots on Figure 87.

Metals concentrations were variable among locations and sampling rounds, and extreme or outlier concentrations were evident for most metals. Maximum sitewide concentrations of total metals based on grand means (means for sampling years 1 through 5) for individual locations exceeded median concentrations by at least two orders of magnitude for arsenic, cadmium, copper, lead, and zinc (Table 67). The ranges between the sitewide median and maximum concentrations of some metals were extremely large. The maximum sitewide 5-year average for zinc (52,625 µg/L) exceeded the sitewide median (132 µg/L) by almost 400 fold. Similar differences occurred for arsenic (140 fold), cadmium (390 fold), copper (152 fold), and lead (118 fold). Attachment G3 and Figures 38 through 43 show spatial trends in the distribution of certain metals, although these trends are obscured by high variability throughout the sampling years in many cases.

Summaries of the distribution and relative concentrations of individual inorganic COPECs in surface water and comparison with AWQC are provided below.

Arsenic in Surface Water

Total concentrations of arsenic were generally highest in the ditches and RASS 4 wetland, with 5-year, areawide means in these two areas of 81.7 (maximum of 668.8 µg/L) and 33.8 µg/L (maximum of 56.4 µg/L), respectively (Table 67). Four locations in the main slough had elevated concentrations of arsenic during one or more sampling rounds; the 5-year grand mean and maximum for the slough was 13.3 and 220 µg/L. The acute surface water criterion for total arsenic was exceeded at least once and was recorded in the ditches, slough, and RASS 4 wetland during the last 3 years of sampling (Figure 86). The 5-year, areawide mean and UCL_{95} for total arsenic in the ditches exceed the acute surface water criterion (Table 67). None of the 5-year areawide averages or UCL_{95}s for the remaining aquatic habitats exceeded the chronic criterion for total arsenic. Concentrations exceeding the acute criterion for dissolved arsenic were detected in two ditch locations during year 5 of monitoring (Table 68).

Cadmium in Surface Water

The highest average concentrations of total cadmium were in Nichols Creek and the ditches, with 5-year, areawide means of 6.4 (maximum of 124.7 µg/L) and 4.0 µg/L (maximum of 45.5 µg/L), respectively (Table 67). Concentrations of total cadmium were elevated at four slough locations during at least one sampling round; the 5-year grand mean and maximum for the slough was 1.9 and 40.7 µg/L. The acute criterion for total cadmium was exceeded in at least one location from the ditches, main slough, and Nichols Creek during the last 3 years of sampling (Figure 86). Total cadmium exceeded the acute criterion at three locations in the RASS 4 wetland, but only when concentrations were estimated by substituting the full, validated result for ND samples. Cadmium was below the dissolved criterion at all locations sampled during monitoring years 4 and 5 (Figure 87). The 5-year, areawide mean and UCL_{95} concentrations were below the chronic criterion for all aquatic habitats.

Copper in Surface Water

Average concentrations of total copper were highest in the ditches and RASS 4 wetland, with 5-year, areawide means of 134.2 (maximum of 1,539 µg/L) and 110.6 µg/L (maximum of 332.9 µg/L), respectively, reported from each area (Table 67). Total copper showed the highest number of locations exceeding the acute surface criterion of any of the six metals investigated during the 5 years of postremediation monitoring. More than 40 locations in the main slough, 30 locations in the ditches, and 10 locations in Nichols Creek exceeded the acute criterion for total copper at least once during the last 3 years of monitoring (Figure 86). Total copper also exceeded the acute criterion at several locations in the RASS 3 pond and RASS 4 wetland. The acute criterion for dissolved copper was exceeded at least once at nine locations in the main slough, six locations in the ditches, and at two locations in Nichols Creek during monitoring years 4 and 5 (Figure 87). The 5-year, areawide mean and UCL_{95} for copper exceeded the acute criterion in the main slough, ditches, Nichols Creek, RASS 3 pond, and RASS 4 wetland (Table 67). The 5-year, sitewide mean (58.5 µg/L) and UCL_{95} (83.2 µg/L) for total copper in all aquatic habitats also exceeded the acute criterion. It should be noted, however, that these numbers probably overestimate the extent of copper contamination in surface water at the Litigation Area, as the DLs for both total and dissolved copper frequently exceeded the surface water benchmarks. Many of the concentrations reported were estimated from ND samples. Still, copper is a COPEC in surface water throughout much of the site.

Lead in Surface Water

The highest average concentrations of total lead were in the RASS 4 wetland, ditches, and in Nichols Creek, with 5-year, areawide means of 83.2 (maximum of 263.2 µg/L), 38.6 (maximum of 332.9 µg/L), and 37.9 µg/L (maximum of 279 µg/L), respectively, reported from each area (Table 67). Total lead concentrations exceeded the acute surface water criterion in a least one location during the last 3 years of monitoring in the main slough, ditches, Nichols Creek, and the RASS 4 wetland (Figure 86). Dissolved concentrations of lead were below the chronic criterion at all locations sampled during monitoring years 4 and 5 (Figure 87). The 5-year, areawide averages and UCL_{95}s for total lead exceeded the chronic criterion in every aquatic habitat. The 5-year, areawide UCL_{95} for total lead in the RASS 4 wetland also exceeded the acute criterion. Both the 5-year, areawide average and UCL_{95} concentrations of total lead calculated for all aquatic habitats exceeded the chronic criterion.

Selenium in Surface Water

Average concentrations of total selenium were all below the chronic surface water criterion in each of the aquatic habitats during the 5 years of postremediation monitoring (Figure 86). The highest 5-year, areawide means for total selenium were detected in the Nichols Creek reference area (4.23 µg/L), Nichols Creek (2.15 µg/L), and in the RASS 4 wetland (2.12 µg/L); average concentrations were only slightly lower in the ditches (1.93 µg/L), RASS 3 pond (1.62 µg/L), and main slough (1.51 µg/L) (Table 67). The maximum 5-year, areawide concentration of total selenium was detected in the ditches (12.9 µg/L). This 5-year, areawide maximum is more than 20 times less than the acute criterion for selenium (290.6 µg/L) and is only approximately 2 times greater than the chronic criterion of 5 µg/L.

Zinc in Surface Water

The highest average concentrations of zinc were detected in Nichols Creek, with a 5-year, areawide mean concentration of 2,750 µg/L (maximum of 52,625 µg/L) (Table 67). Elevated concentrations of zinc were also detected in the ditches, main slough, RASS 4 wetland, and RASS 3 pond. Areawide average concentrations in each of these areas for the 5 years of monitoring were 886.5 (maximum of 6,839 µg/L), 621.3 (maximum of 14,792 µg/L), 525.8 (maximum of 1,605 µg/L), and 458.6 µg/L (maximum of 696.4 µg/L). Following copper, zinc showed the greatest number of locations where total concentrations exceeded the acute surface water criterion (Figure 86). More than 20 locations in both the main slough and ditches and 10 locations in Nichols Creek exceeded the acute criterion for total zinc at least once during the last 3 years of monitoring. The criterion for total zinc was exceeded several times in the RASS 3 pond and in the RASS 4 wetland. The 5-year, areawide means and UCL_{95}s in each of the aquatic

habitats exceeded the acute criterion for total zinc, as did the sitewide mean (1,136 µg/L) and UCL_{95} (1,834 µg/L) for all aquatic habitats pooled (Table 67). Concentrations of dissolved zinc were below the chronic surface water criterion as all locations sampled during years 4 and 5 of the monitoring program (Figure 87).

5.3 BIOAVAILABILITY AND BIOACCUMULATION

Only the bioavailable fraction of total metal concentrations pose a risk. Consideration of the bioavailability and bioaccumulation potential of chemicals is therefore important to understand risk implications of total concentrations of chemicals detected in sediment and surface water and for interpreting the results of bioassays conducted using bulk sediment. Discussion of bioavailability and bioaccumulation in this section is focused on inorganic chemicals, although some of the basic concepts that are described apply to many classes of organic chemicals as well. The decision to focus on inorganic chemicals was made based on the reevaluation that was conducted for organic chemicals and presented in Sections 5.1.1 and 5.2.1.

The discussion of bioavailability and bioaccumulation in this section is presented in three parts: (1) definition and general discussion of bioavailability (Section 5.3.1); (2) discussion of parameters that affect bioavailability of metals in sediment (Section 5.3.2); and (3) detailed descriptions of the chemistry, bioaccumulation potential, and toxicity of the six metals at the site (Section 5.3.3).

Section 7.2 provides a summary of the bioavailability and bioaccumulation discussion, and draws conclusions concerning the potential role of bioavailability in explaining the results of toxicity tests performed at the Litigation Area. Uncertainties associated with estimating potential bioavailability of chemical contaminants and for predicting potential toxicity based on bulk concentrations of chemicals in surface water and sediment and from bioassay results are discussed in Section 7.6.

5.3.1 Bioavailability

The uptake of metals by plants and animals from soils, sediment, and water is a complex, dynamic process. A chemical must be available to an organism before it can be accumulated or cause an adverse effect. Bioavailability is the extent to which a substance can be absorbed by a living organism and can cause an adverse physiological or toxicological response. Plants and animals take up bioavailable metals from soils, sediment, and water through contact with external surfaces, ingestion of contaminated soil, sediment, or water, and by inhalation of vapor-phase metals or airborne particles (Hamelink and others 1994). In addition, animals may take up bioavailable metals from their food. Metal intake can occur through any or

all of these routes. A fish, for example, can take up a metal directly from environmental media through its gills, its skin, or through incidental ingestion of sediment; however, it may also ingest and ultimately absorb contaminants through consumption of food (Campbell and others 1988).

Although exposure is a simple concept, accurately describing the fate and transport of chemicals from their source to a site of toxic action in living organisms can be quite complicated. For exposure to occur, a chemical must leave the environmental matrix, move across several biological membranes, and ultimately concentrate in one or more tissues. A chemical that can move from the environmental matrix to the tissue of a receptor is said to be bioavailable to that receptor.

For ecological evaluations, bioavailability is typically addressed using one or more of the following approaches:

- By directly evaluating exposures to the available fraction of metals present in the environmental media through toxicity tests
- By indirect estimation through the calculation of bioaccumulation factors
- By indirect estimation through evaluations of chemical concentrations in soil and sediment pore water and extracts
- By incorporating bioavailability assumptions (absorption factors) in food chain models and calculations of chemical doses to higher order receptors

With the exception of using absorption factors to estimate bioavailability, all of these approaches have been used at the Litigation Area. Bioassay results were summarized in Tables 78, 80, 81, and 84 and in Section 5.2.2.1, and are further discussed below. Tissue residue results and BAFs calculated for invertebrate and vertebrate tissue collected in 1995 and 2000 are presented in Tables 74, 75, and 76 and discussed in Section 5.3.3. Correlations among metal concentrations in bulk soil and sediment, pore water, and extractions are presented in Table 83 and discussed in Section 5.3.3. All metals in prey tissue were assumed to be 100 percent bioavailable.

A large portion of total metals measured in sediment is typically in a residual fraction as part of the natural mineral matrix. Total metal concentrations alone do not, therefore, accurately reflect the fraction that is biologically available to aquatic and terrestrial organisms (Tessier and Campbell 1987; Campbell and Tessier 1989; Knezovich 1994; Newman and Jagoe 1994). The remaining nonresidual metals in sediment are adsorbed or complexed with various sediment components (such as clay particles; iron, manganese, and aluminum oxide coatings; iron oxyhydroxides; sulfides, carbonates, hydroxides, or chlorides; or dissolved and particulate organic matter) and, depending on physical and chemical

conditions at a site, may be bioavailable. Consideration of physical and chemical conditions at a site, therefore, can aid in estimating the portion of the total measured concentrations that are potentially bioavailable.

Another method of accounting for the bioavailability of metals in soil and sediment is to estimate chemical concentrations in prey and the potential dose received by receptors. This approach provides an estimate of the potential for movement of chemicals through the food chain rather than simply evaluating the potential toxicity from direct exposure.

Organisms are also able to accumulate most bioavailable forms of metals from their food. When an animal consumes a lower trophic organism, any metals that have accumulated in the tissues of that organism can be transferred to the animal. These metals may then be desorbed from the food, dissolved in the gut of the predator during digestion, then partitioned and absorbed into the tissues of the consumer. Metal uptake from food items is addressed by food-chain modeling to upper-level trophic receptors and is discussed in Section 6.0.

5.3.2 Parameters Affecting the Bioavailability of Metals in Sediment

The environment is composed of separate but interconnected compartments such as soil, sediment, water, air, and biota. Metals exist in a variety of forms and partition into phases such as the particulate and dissolved phases. When a chemical is released into the environment, it becomes distributed among these compartments according to properties of the chemical and properties of the environment (Connell 1990).

A wide range of chemical, biological, and physical factors control the form of contaminants in the environment and have the potential to influence the bioavailability of sediment contaminants to biota. The bioavailability of sediment contaminants is also affected by the route of exposure of the organism. The distinction between these categories is somewhat artificial; in reality, complex interactions between chemical, biological, and physical factors result in changes in contaminant bioavailability. A summary of the important factors that affect bioavailability is shown in the following table.

Chemical Factors	Biological Factors	Physical Factors
• AVS concentrations • Redox conditions • pH • Organic carbon content • Iron and manganese oxides • Grain size • Speciation • Solubility • Salinity • Temperature • Dissolved oxygen • Pore water hardness • Interactions among chemicals	• Bioturbation • Biotransformation • Organism size and age • Organism behavior • Diet (sediment ingestion, feeding mechanism, and particle size preference) • Organism response to physicochemical conditions • Route of exposure	• Rate of mixing • Rate of sedimentation • Diffusion • Resuspension

5.3.2.1 Chemical Factors

Contaminants in dynamic environments such as wetland sediment and upland soils partition among particulate and solute phases, form complexes that alter their bioavailability, and undergo biogeochemical transformations into forms that may differ in their toxicity and bioavailability to ecological receptors. Chemical conditions to a large extent determine the degree of association with particles (for example, sorption, desorption, precipitation, and dissolution). This association is important because the potential bioavailability of sediment-associated chemicals such as divalent metals is primarily related to the amount of chemical freely available in sediment pore water.

Factors that affect the bioavailability of sediment metals include the redox (or E_h), pH, AVS and total sulfide, sediment organic carbon content, grain size, speciation, solubility, salinity, pore water hardness, temperature, and interactions among contaminants. These are discussed briefly in the following text, and their effects on bioavailability of arsenic, cadmium, copper, lead, mercury, selenium, and zinc are summarized in the following table. This discussion is not intended to be a definitive review of all the factors that potentially affect contaminant bioavailability. Several reviews have outlines the major factors affecting the bioavailability of sediment contaminants, including Landrum and Robbins (1990) and Hamelink and others (1992).

Chemical Factor	Effect on Bioavailability
E_h (redox)	↑ E_h, ↓ metal bioavailability
PH	low pH, ↑ metal bioavailability (cadmium, copper, lead, mercury, zinc) high pH, ↑ metal bioavailability (arsenic, selenium)
SEM-AVS	SEM-AVS less than 0 indicates decreased availability of metals (cadmium, copper, lead, nickel, zinc)
Total sulfide	↑ sulfide, ↓ metal bioavailability (cadmium, copper, lead, nickel, zinc)
TOC	↑ TOC, ↓ metal bioavailability
Iron and manganese oxides	↑ Iron and manganese oxides, ↑ metal bioavailability (under anoxic conditions) ↑ Iron and manganese oxides, ↓ metal bioavailability (under oxic conditions)
Grain size	Effect on bioavailability unknown ↑ grain size, ↓ TOC
Solubility	↑ solubility, ↑ metal bioavailability
Speciation	Variable
Salinity	Freshwater generally has higher capacity to maintain metals in soluble or particulate form; cadmium is more toxic to freshwater organisms. Metals sorbed to particulates or dissolved ligands in freshwater may desorb as salinity increases (↑ metal bioavailability)
Dissolved oxygen	↑ oxygen, ↓ metal bioavailability (cadmium, copper, nickel, and zinc)
Temperature	↑ temperature, ↑ metal bioavailability (↑ uptake of contaminants)
Pore water hardness	↑ hardness, ↓ metal bioavailability (cadmium, cobalt, copper, mercury, and zinc) Freshwater and saltwater interfaces may result in a local ↑ metal bioavailability
Interactions among contaminants	Variable or unknown

Oxidation-reduction Potential

Redox is a measure of the tendency of a given system to act as an oxidizing (electron acceptor) or a reducing (electron donor) agent. In wetlands, sulfur, iron, manganese, and nitrogen are the most important elements involved in redox processes in submerged sediment. Both iron and manganese are in the divalent, relatively insoluble state in sediment. Iron oxides are an important sink for metals in oxic conditions because of the rapid adsorption of metals to negatively charged sites on the surfaces of iron oxides.

Hydrous iron and manganese oxides that form rapidly when reduced sediments are oxidized may scavenge soluble metalloids or metals, such as arsenic, copper, and zinc, from the water column by coprecipitation (USACE 1989). In aerobic or oxic conditions, hydrous iron oxides tend to decrease the bioavailability of sediment-bound arsenic, copper, lead, and zinc (Luoma and Bryan 1978; Tessier and Campbell 1987). Iron and manganese oxides are reduced under anoxic conditions and become more soluble in water; formerly associated metal ions may then become more bioavailable (Mayer and others 1994).

Most observations at the Litigation Area suggest that the thickness of the oxidized layer in sediment ranges from 1/2 inch to several inches. Fine Bay Muds exist under mostly reduced conditions under this relatively thin layer of oxidized sediment (TtEMI 1999). Because of physical perturbation, however, such as tidal inundation and the movement of animals such as fish, otters, muskrat, turtles, and wading birds, it is assumed that the upper 6 inches of sediment may be subject to periodic oxidizing conditions. Bioturbation by infauna is also known to increase the mobility of sulfide-bound metals by creating more oxic conditions (Greene and Chandler 1994).

Negative Logarithm of the Hydrogen Ion Concentration (pH)

The pH greatly affects the toxicity of contaminants. For metals, the free ionic or hydrated form is more toxic that the undissociated form; therefore, metals are generally more toxic in acidic than in alkaline environments because metals generally become more bioavailable as pH decreases (Mayer and others 1994).

Changes in redox of sediment can allow the release of metals to the solute phase because of associated changes in pH. Insoluble sulfides of many metals formed under reduced conditions are rapidly oxidized when conditions become aerobic, releasing soluble metal ions. Oxidation of iron and manganese produces hydrogen ions, while sulfide oxidation produces sulfate; both of these processes result in an increase in acidity. Generally, free metal ions tend to be present in greater abundance and are more available at low pH and under oxidizing conditions (USACE 1989). A change to more oxic and acidic conditions, such as those that occur in sediment disturbance or bioturbation, may therefore increase the mobility of cadmium, copper, lead, mercury, and zinc. Elements such as selenium and arsenic, on the other hand, are generally more soluble under alkaline conditions (Hong and others 1994).

The pH in Litigation Area soil and sediment samples during monitoring years 1 through 5 ranged from 4.77 to 9.80, with a mean value of 6.7; most locations were between 6.5 and 7.6. Within the aquatic habitats, only two locations in Nichols Creek reported pH below 5.5 in sediment. Because of the

relatively neutral pH of most aquatic habitats at the Litigation Area, increased bioavailability associated with more acidic conditions is not likely.

Acid Volatile Sulfide and Total Sulfide

AVS is an important binding phase in reduced sediment for some divalent metals of toxicological interest (Ankley and others 1996). AVS is operationally defined as the fraction of sulfide minerals of which iron sulfide predominates (Di Toro and others 1990; Carlson and others 1991). In the presence of AVS in sediment, certain metals including copper, cadmium, lead, nickel, zinc (Ankley 1996; Ankley and others 1996) and possibly arsenic and mercury (Luoma 1989; Allen and others 1993; Ankley and others 1996; Neff 1997; Berry and others 1998) precipitate as their respective metal sulfides. These sulfides are insoluble in pore water and are not bioavailable (Di Toro and others 1990). If the molar concentration of AVS in sediment is higher than the sum of the molar concentrations of the SEM, all of the metals are thought to be bound and not bioavailable. The relationship can be summarized as follows:

SEM-AVS > 1, metals are present in bioavailable forms

SEM-AVS < 1, metals are not likely to be bioavailable

Thus, the concentration of bioavailable metal can be calculated using the following equation:

$$[\text{Metal}]_{\text{Bioavailable}} = [\text{Metal}_{\text{SEM}} - \text{AVS}]*(\text{MW}_{\text{Metal}})$$

where:

AVS	=	Acid volatile sulfide
MW	=	molecular weight of the metal

Comparing the difference of SEM with AVS is one method of assessing bioavailability of metals in submerged sediment. This ratio has been successfully used to predict the toxicity of some divalent metals such as copper, cadmium, lead, nickel, and zinc (DiToro and others 1990; Ankley and others 1994). The SEM-AVS approach does not, however, prove satisfactory in oxic or partially reduced *in situ* sediments such as those that occur in a periodically inundated tidal wetland (Mayer and others 1994) or nontidal wetlands subject to seasonal drying. Other possible explanations for the mixed results of the AVS theory include the following:

1. The presence of other solid phases (for example, iron and manganese oxides) and complexing ligands (for example, natural organic matter) that might be successfully competing for dissolved metals in sediment

2. The fact that organisms might alter the condition of their immediate environment, thereby exposing themselves to conditions different from those measured in the bulk sediment

At all but one site at the Litigation Area, SEM-AVS was less than 1.0, indicating that divalent metals such as copper, cadmium, lead, nickel, and zinc are not likely to be bioavailable (Table 86).

Total Organic Carbon and Grain Size

Sediment TOC consists primarily of humic matter and fulvic acids resulting from the breakdown of plant and animal material. These and other natural organic ligands can form complexes and chelates with metals, thereby increasing their solubility (Hawker 1990). Although many metals form bonds and aggregations within an organic matrix, no simple relationship between TOC and bioavailability can be predicted. In general, TOC is assumed to increase with increasing proportion of fine particles.

The surface area of individual sediment particles increases as sediment particle size decreases (USACE 1989). As surface area increases, the number of charged binding sites increases, resulting in more sites for adsorption. Grain size is thus an important variable, as smaller particles carry greater contaminant loads and organic carbon fractions than do larger particles.

Sediment at the Litigation Area consists of predominantly fine-grained silts and clays, with particle sizes less than 75 to 250 millimeters (TtEMI 2000a). TOC concentrations at the Litigation Area ranged from 1,630 to 737,000 mg/kg for sediment samples collected in all habitats during monitoring years 1 through 5 and from 19,800 to 211,000 mg/kg for samples collected from the ditches and slough in October 2000. The sitewide mean TOC concentration for all samples from the Litigation Area was 103,696 mg/kg. In general, the small grain size in the Bay Muds that predominate in Litigation Area sediment indicates a high capacity for retention of particle-bound contaminants.

Solubility

Metals have a wide range of solubility. WET is a leaching test used to determine the amount of specific adsorbed contaminant that can be leached from solid phases of the soil or sediment using a solution designed to simulate leaching in the field. To address the potential mobility of metals during rain or flooding events as well as the potential biological interactions between chemicals in the rhizosphere and exposed biota (such as soil macroinvertebrates and plant roots), deionized water (similar to rain) and citric

acid (similar to acid rain) are used to leach metals from soil and sediment (State of California 1990). WET ratios using deionized water are presented in Table 72.

The distribution of dissolved metals in pore water and fluxes of metals across the sediment-water interface are closely related to and rapidly influenced by the oxygen regime (Sundby 1994). Concentrations of metals in pore water compared with bulk sediment at the Litigation Area are shown in Table 73. Sulfide-bound metals associated with anoxic sediment are likely to be released into pore water during centrifugation. Although the results from pore water samples may, therefore, overestimate the immediately available fraction of metals, they may better represent longer-term exposure as surficial sediments are disturbed by biotic or abiotic process.

Metals present at Litigation Area sites are not readily water soluble. Deionized WET results normalized to bulk sediment concentrations ranged from 0.0012 to 5.12 percent, indicating that less than 5 percent of the metal present in the bulk is water soluble (Table 72). For the most part, metals were less than 1 percent soluble (average WET ratio of 0.60 percent). In pore water, concentrations normalized to bulk sediment concentrations ranged from 0.002 to 0.3 percent, indicating that less that 0.3 percent of the metal is present in the pore water (Table 73).

Salinity

In general, marine and freshwater taxa have similar sensitivities to most inorganic and organic contaminants, and the bioavailability of chemicals may be similar in both environments (Knezovich 1994). One exception is cadmium, which is generally more toxic to freshwater organisms; this may be because of differences in the speciation of cadmium, which exists in the ionic form in fresh water and as a complexed form (cadmium chloride [$CdCl_2$]) in seawater. Bivalves have been shown to increased bioaccumulation of cadmium as salinity decreases (Hawker 1990).

Fresh water generally has a higher capacity to maintain many metals in soluble or suspended particulate form than does salt water (Hawker 1990). Metals sorbed to particulates or dissolved ligands (such as chloride, sulfate, and carbonate) in fresh water may be subject to desorption as salinity increases due to competitive exchange of cations (sodium, potassium, calcium, and magnesium) on the sorptive substrates (Knezovich 1994). Metals released during this desorption process will likely be readsorbed onto particulate matter; however, short-term changes in bioavailability may occur at steep salinity gradients. Changes in bioavailability may thus occur in estuarine habitats such as the Litigation Area where the freshwater and saltwater transition fluctuates spatially and temporally. Some studies have indicated that the toxicity of some metals, such as copper and cadmium, is inversely related to salinity; these effects are

possibly linked to or confounded by effects on the ability of organisms to osmoregulate (Knezovich 1994).

Salinity varies seasonally and annually at the Litigation Area and is strongly tied to precipitation patterns and water management for delta outflows. Salinity measured in surface water in May at the Litigation Area during monitoring year 5 ranged from 0 to 9.8 ppt (mean 1.44 ppt) (TtEMI 2000a). Salinity ranged from 0.33 to 21 ppt (mean of 1.26 ppt) in Litigation Area sediment and soil during all 5 years of monitoring. Soil salinity was substantially higher in samples from the marsh surface, with a mean and maximum salinity of 2.20 and 21 ppt. Ranges of mean and maximum salinities in other habitats were 0.33 to 1.52 ppt and 0.33 to 3.0. Within aquatic habitats only, only the ditches reported average salinities in sediment that exceeded 1.0 (mean of 1.52 ppt).

Hardness

Hardness refers to the concentration of multivalent cations, particularly calcium and magnesium, in water. As a general rule, the presence of divalent cations (calcium and magnesium) in surface water or pore water may cause particulate, colloidal, or soluble organic matter to flocculate and settle from the water column; trace metals may coprecipitate with the flocculated material (USACE 1989). In surface water, the general relationship between metal toxicity and hardness shows that most metals are less harmful in harder water (Mayer and others 1994); a similar relationship for organic analytes has not been shown. In general, calcium and magnesium cations do not affect the speciation of cationic chemicals but may compete for the same ligands as binding sites. Hardness may also affect the speciation of anionic chemicals (Erickson and others 1994).

A variety of studies have shown decreased toxicity to aquatic organisms with increased hardness for cadmium, cobalt, copper, and zinc; similar studies have shown lower mercury and zinc residues in fish exposed to waters of increasing hardness (Mayer and others 1994). High calcium levels have been shown to decrease cadmium bioaccumulation in freshwater and saltwater crustaceans (Hawker 1990). Hawker (1990) demonstrated that the uptake of cadmium in snails and fish was less in hard water (defined as 150 micrograms per gram [µg/g] total divalent calcium and magnesium) than in soft water (0 µg/g total divalent calcium and magnesium). Other studies have shown negligible effects of hardness on metal toxicity (Erickson and others 1994).

The transition from fresh water to salt water results in a wide variability in hardness. Fresh water has a salt composition determined by local geologic factors and is dominated by calcium; saltwater is more uniform in its composition and is dominated by sodium. In estuarine or brackish conditions, the pH and

hardness may vary spatially and temporally and are generally lower than values for saltwater environments (Knezovich 1994). Because hardness is often correlated with pH, effects of each component are difficult to distinguish.

Hardness measured in surface waters at the Litigation Area during monitoring year 5 ranged from 111 to 2,690 mg/L, with an average of 544 mg/L (TtEMI 2000a). Surface and pore water at the Litigation Area can, therefore, be considered relatively hard, with reduced bioavailability of metals.

Temperature

Metabolic rates for ectothermic ("cold-blooded") animals generally rise with increasing temperature, resulting in increased diffusion or uptake of water and solutes across gill surfaces and cell membranes (Hawker 1990; Mayer and others 1994). In general, the metabolism of ectothermic organisms increases approximately two-fold with every 10-°C increase in temperature (Hamelink and others 1994). Increases in temperature may thus result in increased toxicity as organisms may be exposed to greater amounts of chemicals because of increased diffusion or more active uptake (Hamelink and others 1994). Some studies do not support this relationship; these studies primarily involved organic chemicals such as DDD, DDT, methoxychlor, pyrethroids, and ammonia, all of which were found to be negatively correlated with temperature (Macek and others 1969; Mauck and others 1976; Nimmo and others 1989). Others have stated that there is no pattern to explain the effects of temperature on the toxicity of chemicals to aquatic organisms exposed to zinc (Sprague 1986). In general, however, studies show that rises in temperature causes the acute toxicity of most chemicals to increase by an average of 3.1 times per 10 °C rise; the factor was higher (up to 5.1 times) for organophosphate chemicals (Mayer and Ellersieck 1988, as cited in Hamelink and others 1994).

Water temperatures for Suisun Bay range from 8 to 22 °C throughout the year (California Department of Water Resources and U.S. Bureau of Reclamation 1994); most of the water in the sloughs and ditches of the Litigation Area flushes twice daily with tides. Shallow water in the RASS 3 and RASS 4 ponded wetlands is expected to significantly increase in temperature during warm summer days.

5.3.2.2 Biological Factors

Bioturbation of sediment by benthic organisms can alter the physical and chemical characteristics of the sediment. A recent study of the effects of bioturbation on the bioavailability of metals showed that bioturbation could enhance the bioavailability of some cationic metals in surficial sediment. Burrowing activity of the oligochaete *Lumbriculus variegatus* significantly reduced AVS concentrations in surficial

sediment and resulted in elevated pore water concentrations of cadmium (Peterson and others 1996). The physical reworking of sediment in laboratory microcosms by oligochaetes has also been shown to result in enhanced contaminant concentrations (Karickhoff and Morris 1985). Biotransformation and biodegradation also affect bioavailability, and are strongly influenced by the degree to which the compound in associated with sediment particles.

Basic routes of exposure for aquatic organisms include direct exposure to dissolved contaminants in surface water, exposure to dissolved contaminants in sediment pore water, ingestion of contaminated sediment particles, and ingestion of contaminated prey. Exposure to dissolved contaminant concentrations in sediment pore water appears to be the predominant route of exposure for most benthic organisms (Day and others 1989). However, sediment ingestion might be a significant route of exposure for some species (Landrum 1989; Harkey and others 1994; Meador and others 1995; Lee and others 2000). Adams and others (2000) reported that 70 percent of cadmium and 95 percent of selenium are taken up via particle ingestion by clams and other aquatic invertebrates; copper and zinc may also be taken up by ingestion.

Feeding mechanism may also play a role (Lee and others 2000). The depth to which an organism burrows, the type of feeding mechanism it uses (for example, filter feeding or particle ingestion), the size range of sediment particles is consumes, and its diet all have a large influence on the concentration of contaminant to which the organism will be exposed (Harkey and others 1994). For example, oxidation of salt marsh soil by *Arenicola marina*, a burrowing invertebrate lugworm, has been reported to affect the biogeochemistry of nitrogen and silicates (Huettel 1990) and of sulfides (Groenendaal 1979), all of which affect metal bioavailability. Benthic organisms may preferentially ingest particles of different sizes. For example, soft bottom forms such as deposit feeders prefer fine grains (such as silt, silty clay, clayey silt and muck), whereas sandy-bottom forms and suspension feeders prefer larger grains (sand and sandy silt) (Day and others 1989). For fish, direct exposure to gill surfaces and ingestion of sediment, water, and prey tissue is clearly the predominant route of exposure.

Many organometallic compounds are formed as a result of biologically mediated processes. Lead and mercury can be bioalkylated by microorganisms. Organic forms of arsenic can be formed by phytoplankton and passed along the food chain (Hawker 1990). The availability and toxicity of several metals and metalloids, such as arsenic, selenium, and mercury, increase as a result of biomethylation, and they become more lipid soluble (Mayer and others 1994). In general, an increase in the number of organic substitutions on a metallic compound tends to make the compound more hydrophobic and therefore more likely to bioaccumulate (Hawker 1990).

5.3.2.3 Physical Factors

Sediment is a dynamic environment characterized by a wide range of competing processes with variable rates. The rate of mixing in surficial sediment layers by physical processes such as turbulence and bioturbation competes with the rate of sedimentation to determine the depth to which sediment will be buried. Concentration gradient-driven diffusion processes also affect the mobility and bioavailability of sediment-associated contaminants. Resuspension can also have a large impact on the contaminant bioavailability by either reexposing epibenthic filter feeders to contaminated particulates or increasing the aqueous concentration of a contaminant through desorption from the particles within the water column (Landrum and others 1994). The concentration profile within the sediment is very important to bioavailability and subsequent potential for bioaccumulation because is determines the chemical environment of the sediment and the physical bioavailability of the contaminant to biological organisms (that is, whether organisms will be in contact with the contaminant).

5.3.3 Bioavailability, Bioaccumulation Potential, and Toxicity of Seven Metals at the Litigation Area

The chemical behavior, bioavailability, bioaccumulation, and toxicity of arsenic, cadmium, copper, lead, mercury, selenium, and zinc are discussed in the following sections. Chemicals in sediment can enter the water column in several ways, including diffusion and advection from sediment (often biologically mediated), and sediment resuspension followed by chemical release. Figures 88 through 92 show biogeochemical cycles for groups of inorganic chemicals, including the transportation pathways in the environment, especially sediment; the routes through which metals enter plants and aquatic organisms; the pathways that recycle metals; and the metal forms (for example, adsorbed, bound, dissolved, and volatile) occurring in the environment. The figures are schematic; vertical and horizontal scales were arbitrarily selected to enhance the clarity of the figure. The ionic forms or valence states of each metal are intentionally omitted; these figures are intended to be tools for visualizing and assessing overall geochemical fate, transport, and availability of metals at the Litigation Area.

5.3.3.1 Bioavailability, Bioaccumulation Potential, and Toxicity of Arsenic

Sediment and soil are primary sinks for arsenic at the Litigation Area (see Figure 88 for conceptual model of biogeochemical cycle). Arsenic is transported into sediment in two ways. First, arsenic dissolved in water coprecipitates with iron and manganese oxides that also are dissolved in water (De Vitre and others 1991; Sadiq 1992a; Gambrell 1994; American Petroleum Institute [API] 1998). Coprecipitation results in arsenic coating iron solids; these solids then settle by gravity into the sediment. Second, particles

(typically organic in nature) with adsorbed arsenic also settle out of the water column into the sediment (Sadiq 1992a). In salt marshes, iron (present either dissolved in water or as a solid in the sediment) is typically the dominant factor controlling arsenic availability (Otte and others 1991; Doyle and Otte 1997). Two other factors, sulfide and organic carbon, may play lesser roles in determining arsenic behavior in anoxic sediment (De Vitre and others 1991; Gambrell 1994; API 1998). Under anoxic conditions in sediment, some (but not all) forms of arsenic bind to sulfide forming insoluble precipitates (Morse 1994). SEM-AVS differences in samples collected in October 2000 were negative, indicating low bioavailability, in all samples except at ditch location R01DH302 (Table 86). Total sulfide concentrations averaged 6.22×10^{-5} molar (Table 86); these concentrations are sufficiently high to bind arsenic concentrations measured in Litigation Area sediment, suggesting that arsenic in sediment is unavailable. Sediment at the Litigation Area also contained high concentrations of organic carbon (sitewide mean TOC greater than 100,000 mg/kg); arsenic binds tightly to organic carbon, further reducing its availability.

Arsenic in Litigation Area sediment is therefore generally unavailable, being either bound or precipitated on iron solids, based on the following factors: (1) iron concentrations in Litigation Area sediment are high (range of 29,200 to 67,400 mg/kg, based on October 2000 samples) (Table 55), (2) total sulfide concentrations in Litigation Area sediment are high (mean of 1,998 mg/kg and range of 306 to 5,270 mg/kg) (Table 56), (3) the total organic carbon concentrations in the Litigation Area sediment are high (sitewide average is greater than 100,000 mg/kg), and (4) the majority of the Litigation Area sediment are anoxic, with SEM-AVS differences that indicate low bioavailability (Table 86).

The fate of arsenic in sediment depends upon whether the sediment is reduced (anoxic) or oxidized (oxic) (Masscheleyn and others 1991; U.S. Department of the Interior [DOI] 1998). In reduced sediment, the arsenic-coated iron solid will remain undissolved for an indefinite period. In oxidized sediment, iron will begin to dissolve causing some arsenic to be released in a dissolved form (Masscheleyn and others 1991). When arsenic desorbs from dissolving particulates or precipitates, the soluble arsenic diffuses into the pore water and ultimately into the water column (Soma and others 1994). The rate of release of arsenic from sediment into the water column, therefore, depends on the rate at which anoxic sediments become oxidized. The principal route at the Litigation Area through which anoxic sediment could become oxidized is sediment mixing by wind or wave action during storms. If sufficient sediment mixing should occur resulting in oxidized sediment conditions, iron and manganese oxides would begin to dissolve releasing trace quantities of arsenic into sediment pore water. This release of arsenic will not necessarily cause toxicity (Masscheleyn and others 1991; Eisler 1994). The typical form of arsenic (65 to 98 percent) in pore water in marshes is pentavalent arsenite (Masscheleyn and others 1991); this form of arsenic is less toxic than the trivalent form (Eisler 1994; Carbonell and others 1998). In general, trivalent arsenic is

taken up and accumulated; although pentavalent arsenic is absorbed as well, it is usually eliminated rapidly through excretion (Bertolero and others 1987).

Dissolved arsenic is typically present in low concentrations in surface water at the Litigation Area (Table 68). Between pH 4 and 8 (typical of the Litigation Area), arsenic acid $(H_2AsO_4)^-$ is probably the most abundant form (Tamaki and Frankenberger 1992). Dissolved arsenic typically enters aquatic animals across the gills, but benthic invertebrates and fish also ingest particles with adsorbed arsenic (Luoma 1983; Mayer and others 1996). The magnitude and significance of this route of entry is uncertain (Nalepa and Landrum 1988). Some invertebrates accumulate arsenic (DOI 1998), but it does not biomagnify up the food chain (Eisler 1994). Major factors influencing arsenic availability and toxicity to aquatic animals include pH, water and sediment organic content, water and sediment phosphate concentration, and arsenic speciation (Brannon and Patrick 1987; Gambrell 1994; DOI 1998).

Measurements of dissolved arsenic in surface water averaged 11.3 µg/L (range of 1 to 109 µg/L) for all sites investigated in the Litigation Area from monitoring years 4 and 5 (Table 68). Dissolved arsenic concentrations averaged 1.8 µg/L (range of 1.1 to 4.1 µg/L) for samples collected in the ditches and slough during October 2000 (Table 57). These concentrations are below those observed to cause toxicity in aquatic invertebrates and fish. Lethal concentrations 50 percent (LC_{50}) values for various fish include 41 mg/L (bluegill) and 31 mg/L (striped bass and knifefish) (Moore and others 1990; Bartell and others 1992; Richardson 1992); 96-hour effects concentration 50 percent (EC_{50}) values for fathead minnow ranged from 141 to 144 mg/L (Richardson 1992). Invertebrates such as *Aplexa hypnorum* demonstrated 48-hour LC_{50} values of 25.4 mg/L (Bartell and others 1992). Because of the very low concentration of dissolved arsenic in Litigation Area surface waters, arsenic uptake is expected to be minimal. Concentrations of arsenic measured in the tissue of fish and aquatic invertebrates were generally low in all samples analyzed, suggesting that significant uptake and accumulation were not occurring (Tables 74 and 76).

5.3.3.2 Bioavailability, Bioaccumulation Potential, and Toxicity of Cadmium

Sediment and soil are primary sinks for cadmium at the Litigation Area (see Figure 89 for conceptual model of biogeochemical cycle). Cadmium is transported into sediment in two ways. First, particles (typically organic in nature) with adsorbed cadmium settle by gravity into the sediment (Rosental and others 1986; Sadiq 1992b). Second, cadmium coprecipitates with dissolved iron and manganese oxides resulting in a cadmium-coated iron solid; the resulting solid settles by gravity into the sediment (Rosental and others 1986; Government of Canada 1994). The behavior of cadmium in sediment is primarily

determined by the redox status of the sediment. In anoxic or moderately hypoxic sediments, cadmium binds to sulfides forming an insoluble solid that is not available for uptake by animals and plants (Boulegue 1983; Salomons and others 1987; Sadiq 1992b). SEM-AVS differences in samples collected in October 2000 were negative, indicating low bioavailability in all samples except at ditch location R01DH302 (Table 86). Total sulfide concentrations averaged 6.22×10^{-5} molar (Table 86); these concentrations are sufficiently high to bind cadmium concentrations measured in Litigation Area sediment, suggesting that cadmium in sediment is unavailable. Sediments at the Litigation Area also contain high concentrations of organic carbon (sitewide mean TOC greater than 100,000 mg/kg); cadmium binds tightly to organic carbon, further reducing its availability. Carlson and others (1991) concluded that cadmium in sediment is not available when the cadmium is precipitated, complexed, bound, or present as cadmium sulfide.

In oxic sediment, the bond between the sulfide and the cadmium is often broken, releasing free cadmium as divalent ions into the sediment pore water. The fate of these ions is determined by pH. If the pH is low (less than six), the ions remain free and ultimately make their way into the water column as dissolved cadmium. If the pH is high (greater than six), the cadmium typically sorbs to particulates or other forms of organic carbon and is unavailable (Sadiq 1992b; Government of Canada 1994). Since most sediment at the Litigation Area is anoxic and the pH in more oxidized surface sediment is consistently neutral (sitewide average of 6.7), one would expect little cadmium to diffuse into the water column.

Dissolved cadmium is typically present in low concentrations in surface water at the Litigation Area. Dissolved cadmium is typically present as a divalent ion (Government of Canada 1994); these free ions usually enter aquatic animals across the gills (Carlson and others 1991; Government of Canada 1994), but benthic invertebrates and fish may also ingest particles with adsorbed cadmium (Luoma 1983; Canli and Furness 1995; Wen-Xiong and Fisher 1996; Mayer and others 1996). The major route of entry of cadmium into fish is across the gills (Government of Canada 1994). For invertebrates, however, particle ingestion may be the more important route of uptake for cadmium; for example, Adams and others (2000) indicated that 60 to 80 percent of the cadmium in amphipods was of particle origin. The toxicity of cadmium in fresh water varies with water hardness; increasing the water hardness decreases the cadmium toxicity.

Measurements of dissolved cadmium in surface water averaged 0.21 µg/L (range of 0.15 to 0.50 µg/L) for all sites investigated in the Litigation Area from monitoring years 4 and 5 (Table 68). Dissolved cadmium concentrations averaged 0.11 µg/L (range of 0.10 to 0.25 µg/L) for samples collected in the ditches and slough during October 2000 (Table 57). These concentrations are below those observed to

cause toxicity in aquatic invertebrates and fish. The lowest chronic value for fish is 1.7 µg/L (Irwin and others 1998). Reported 96-hour LC_{50} values for fathead minnow range from 11.7 to 7,160 µg/L; much of the variation is related to the sensitivity of newly hatched fry compared to older fish (Wren and others 1995; Bartell and others 1992; Irwin and others 1998). Chronic effects in fish have been observed at concentration as low as 0.5 to 1.0 µg/L (Wren and others 1995). Reported 48-hour acute toxicity values for invertebrates ranged from 7.0 to 34,600 µg/L (Wren and others 1995; Irwin and others 1998). Cladocerans, a group of freshwater crustaceans that area particularly sensitive to cadmium, showed 48-hour LC_{50} values in the range of 34 to 60 µg/L (for daphnids) in moderately hard water (Wren and others 1995).

Other factors influencing cadmium toxicity are pH, E_h, the presence of other complexing agents, and other antagonistic metals (such as zinc) (Jarvis and others 1976, as cited in Agency for Toxic Substances and Disease Registry (ATSDR) 1993b; Page and others 1981; Adriano 1992; Sadiq 1992b). Some invertebrates accumulate cadmium, and some authors have proposed that cadmium is biomagnified (Eisler 1985a; Gochfeld and Burger 1982; Beyer 1986, John and others 1987, as cited in ATSDR 1993b). Suedel and others (1994), in a major review of metal biomagnification potential, concluded that published data did not support the conclusion that cadmium was biomagnified up the food chain. Because of the very low concentration of dissolved cadmium in Litigation Area surface water (Table 68), cadmium uptake is expected to be minimal. BAFs for cadmium in fish, tadpoles, amphipods, crayfish, and damselfly larvae were less than 1.0 at all sampling locations (Table 76). BAFs in clam tissue samples where cadmium was detected were all less than 1.0 (Table 74). These findings suggest that cadmium is unavailable and is not being accumulated by aquatic biota at the Litigation Area.

5.3.3.3 Bioavailability, Bioaccumulation Potential, and Toxicity of Copper

Sediment and soil are primary sinks for copper at the Litigation Area (see Figure 89 for conceptual model of biogeochemical cycle). Copper is transported into sediments in at least two ways: (1) settling of particles with adsorbed copper and (2) through coprecipitation with iron (Luoma 1985; Prohic and Kniewald 1987; Sadiq 1992c). In the first case, particles (typically organic in nature) with adsorbed copper settle by gravity into the sediment. In the second case, coprecipitation results in copper coating an iron solid; this solid then settles by gravity into the sediment. The behavior of copper in the sediment is determined by the redox status of the sediment (Sadiq 1992c). In anoxic or moderately hypoxic sediments, copper binds to sulfides forming an insoluble solid that is not available for uptake by animals and plants (Luoma 1985; Sadiq 1992c). SEM-AVS differences in samples collected in October 2000 were negative, indicating low bioavailability, in all samples except at ditch location R01DH302

(Table 86). Total sulfide concentrations averaged 6.22×10^{-5} molar (Table 86); these concentrations are sufficiently high to bind copper concentrations measured in the Litigation Area sediment, suggesting that copper in sediment is bound and unavailable. Sediments at the Litigation Area also contain high concentrations of organic carbon; copper binds tightly to organic carbon, further reducing its availability. Copper in Litigation Area sediments is probably unavailable, being either bound to sulfide or adsorbed on iron solids, for the following reasons: (1) iron concentrations at the Litigation Area are high (29,200 to 67,400 mg/kg, based on October 2000 samples) (Table 55), (2) total sulfide concentrations in the Litigation Area sediments are high (mean of 1,998 mg/kg and range of 306 to 5,270 mg/kg) (Table 56), (3) TOC concentrations in the Litigation Area sediments are high (sitewide average greater than 100,000 mg/kg), and (4) the majority of the Litigation Area sediments are anoxic.

The fate of copper in sediment depends on whether the sediment is reduced (anoxic) or oxidized (oxic). In reduced sediment, the copper-coated iron solid will remain undissolved for an indefinite period. In oxic sediments, the bond between the sulfide and the copper is often broken, releasing free copper as divalent ions into the sediment pore water. As the iron solid begins to dissolve, copper is released in a soluble form. The fate of these copper ions is determined by pH (De Mayo and others 1982). If the pH is low (less than six), the ions remain free and ultimately make their way into the water column as dissolved copper. If the pH is high (greater than six), the copper typically sorbs to particulates or other forms of organic carbon and/or forms complexes and is unavailable (De Mayo and others 1982). Since most sediment at the Litigation Area is anoxic and the pH in the Litigation Area oxic sediments is consistently higher than 6.0, one would expect little copper to diffuse into the water column.

Dissolved copper has, however, been measured in the water column at the Litigation Area at concentrations that exceed both the acute and chronic benchmarks. Measurements of dissolved copper in surface water averaged 20.9 μg/L (range of 1.50 to 139 μg/L) for all sites investigated in the Litigation Area from monitoring years 4 and 5 (Table 68). Dissolved copper concentrations averaged 5.73 μg/L (range of 0.55 to 29.5 μg/L) for samples collected in the ditches and slough during October 2000 (Table 57). Dissolved copper is typically present as a divalent ion; these toxic free ions enter aquatic animals across the gills, though benthic invertebrates and fish also ingest particles with adsorbed copper (Luoma 1983; De Mayo and others 1982). Copper free ions are known to be the most bioavailable form of copper in aquatic systems (Simkiss and Taylor 1989; Miller and others 1992; Phinney and Bruland 1994); however, various factors can affect copper toxicity. The toxicity of copper in freshwater varies with water hardness; increasing the water hardness decreases the copper toxicity (Mayer and others 1994; Erickson and others 1994). Copper is synergistic in the presence of zinc (U.S. Fish and Wildlife Service

[USFWS] 1987, 1993). Since the Litigation Area surface water has a hardness in excess of 400 mg/L as calcium carbonate, one would anticipate that divalent metal toxicity would be somewhat mitigated. Other factors influencing copper toxicity are pH, redox, presence of other complexing agents, and other antagonistic metals (such as phosphate and manganese) (Bodek and others 1988; De Mayo and others 1982; Sadiq 1992c). EPA (1985) reports a 2-day copper EC_{50} for the oyster, *Crassostrea gigas*, of 5.3 µg/L.

Copper is accumulated by all organisms, particularly invertebrates, but is not biomagnified up the food chain (Raymont 1972; EPA 1985; Perwack and others 1980; Furness and Rainbow 1990; Talmage and Walton 1991). Because many invertebrates use copper to transport oxygen in blood (analogous to hemoglobin in mammalian blood), one must be careful when evaluating invertebrate copper body burdens not to identify this normal copper burden as "accumulated copper" (Suedel and others 1994). Because invertebrates can store copper in inert granules (Brown 1982), one must also be careful not to consider this increased copper burden to be toxic to the animal (Nriagu 1979, as cited in DOI 1998; Hamilton and Mehrle 1986; Webb 1987). BAFs for copper calculated for fish, tadpoles, amphipods, crayfish, and damselfly larvae were less than 1 at all sampling locations except one. A BAF of 2.7 was identified in a single crayfish sample from the RASS 3 pond (Table 76). BAFs for copper in clam tissue exceeded one at all three slough reference locations and at slough location R01SH305 sampled in October 2000. BAFs in these four locations ranged from 1.07 at location R01SH305 in the slough to 1.64 at slough reference location SLRSH01, indicating low bioaccumulation.

5.3.3.4 Bioavailability, Bioaccumulation Potential, and Toxicity of Lead

Sediment and soil are primary sinks for lead at the Litigation Area (see Figure 90 for conceptual model of biogeochemical cycle). To discuss the biogeochemistry of lead in sediments, it is first necessary to understand the entry of lead into the sediments from the overlying water. In general, most lead in water is precipitated into the sediment as carbonates or hydroxides (Eisler 1988b; USFWS 1988; Sadiq 1992d). Particles with adsorbed lead also settle out of the water column by gravity into the sediment.

The behavior of lead in sediments is determined by the redox status of the sediment. In anoxic or moderately hypoxic sediments, lead binds to sulfides forming an insoluble solid that is not available for uptake by animals and plants (Wong and others 1978; Bourgoin and others 1991; Sadiq 1992d). SEM-AVS differences in samples collected in October 2000 were negative, indicating low bioavailability, in all samples except at ditch location R01DH302 (Table 86). Total sulfide concentrations averaged 6.22×10^{-5} molar (Table 86); these concentrations are sufficiently high to bind lead concentrations

measured in the Litigation Area sediment, suggesting that lead in sediment is bound and unavailable. Lead in sediment also binds to fine-grained particulates and to organic carbon (Luoma and Bryan 1981; Loring 1982; Schropp and others 1990; Krumgalz and others 1992). Sediment grain size at the Litigation Area was typically greater than 90 percent fines (particles less than 75 microns), and TOC concentrations in sediments were also high (sitewide average greater than 100,000 mg/kg). Both factors further indicate that lead in Litigation Area sediments is bound and unavailable.

The fate of lead in sediment depends upon whether the sediment is reduced (anoxic) or oxidized (oxic). In reduced sediment, lead sulfide and lead bound to organic carbon will remain in these forms for an indefinite period. In oxic sediments, the bond between the sulfide and the lead is often broken, releasing free lead as divalent ions into the sediment pore water. The fate of these ions is determined by pH. If the pH is low (less than six), the ions remain free, and make their way into the water column as dissolved lead. If the pH is high (greater than six), the lead typically sorbs to particulates or other forms of organic carbon and is unavailable. Since most sediments at the Litigation Area are anoxic, and the pH in Litigation Area oxic sediments is consistently higher than 6.0 (sitewide average of 6.7), one would expect little lead to diffuse into the water column. Measurements of lead in the surface water of the Litigation Area confirm this theory; lead in surface water during monitoring years 4 and 5 ranged from 0.50 to 1.01 µg/L (Table 68).

The most abundant forms of lead in water are the divalent ion and chloride and hydroxide complexes (De Mayo and others 1981; USFWS 1988; Sadiq 1992d; Pain 1995). As with most divalent metals, lead solubility in water increases as the pH decreases (USFWS 1988). Since the pH of the Litigation Site surface water is close to neutral, lead solubility was expected to be minimal. The toxic form of lead is the divalent ion (Pain 1995); these free ions generally enter aquatic animals across the gills (Wong and others 1978; Carlson and others 1991; Government of Canada 1994), though benthic invertebrates and fish also ingest particles with adsorbed lead (Luoma 1983; Mayer and others 1996). The toxicity of lead in fresh water varies with water hardness; increasing the water hardness decreases the lead toxicity (Mayer and others 1994; Erickson and others 1994). Other factors influencing lead toxicity are pH, redox presence of other complexing agents, and other antagonistic metals (such as zinc) (De Mayo and others 1981; USFWS 1988; Sadiq 1992d; Pain 1995). For various daphnid species, 48-hour LC_{50} values range from 0.45 to 5.1 mg/L (Bartell and others 1992; EPA 1997b). LC_{50} values for various fish ranged from 1.17 mg/L (rainbow trout) to 4.61 mg/L (fathead minnow) (Bartell and others 1992; Irwin and others 1998). The 96-hour LC_{50}s for smallmouth bass were 2.2, 2.8, and 29.0 mg/L (EPA 1997b). In green mussels, 48-hour LC_{50} values for cadmium averaged 10 mg/L; for shrimp species, 48-hour LC_{50} values range from 3.1 to 5.0 mg/L (EPA 1997b). These concentrations are higher than dissolved concentrations

measured at the Litigation Area in surface water samples collected during monitoring years 4 and 5 (mean of 1.0 µg/L, range of 0.50 to 2.70 µg/L) (Table 68) and during October 2000 (mean of 0.58 µg/L, range of 0.55 to 0.65 µg/L) (Table 57). These higher concentrations suggest that lead present in surface water at the site does not pose a major risk to fish and aquatic invertebrates.

Because of the very low concentration of lead in Litigation Area surface water, lead uptake is expected to be minimal. BAFs calculated for lead in fish, clam, tadpole, amphipod, crayfish, and damselfly tissue were below one at all locations (Tables 74 through 76), suggesting that significant bioaccumulation of lead is not occurring.

5.3.3.5 Bioavailability, Bioaccumulation Potential, and Toxicity of Mercury

Sediment and soil are primary sinks for mercury at the Litigation Area (see Figure 91 for conceptual model of biogeochemical cycle). To understand the biogeochemistry of mercury in sediments, it is first necessary to understand the behavior of mercury in water.

Mercury is transported into water in the following four ways: (1) adsorbed to dust particles which are distributed by wind, (2) adsorbed to soil components in water runoff, (3) in rain, and (4) associated with waste disposal. Once in water, the fate of mercury depends upon its chemical state (DOI 1998). Elemental mercury is insoluble and immediately falls to the bottom of the water body and enters the sediment. Inorganic mercury may dissolve in the water or bind to organic particles and settle by gravity into the sediments (Zillioux and others 1993). Organic mercury dissolves in the water or binds to organic particles. Depending on the chemical form of the dissolved organic mercury, it may be available for uptake into plants and animals (Jenne and Luoma 1977; Breteler and others 1981; Zillioux and others 1993; Government of Canada 1994; Mayer and others 1996). Dissolved mercury is transported into sediments principally by the deposition of insoluble complexes. When mercury dissolves in water, it typically forms complexes with humic and fulvic acids dissolved in the water (Zillioux and others 1993). Many of these complexes are insoluble, and the complex settles by gravity into the sediment. The formation rate of these complexes varies with water pH; lower pHs enhance the formation of the insoluble complexes (Government of Canada 1994). Because the Litigation Area is an estuary with water and sediments containing high percentages of organic materials, surface water mercury concentrations are expected to be low. Dissolved concentrations of mercury were 0.05 µg/L in all ditch and slough samples from October 2000 (Table 57).

The fate of mercury in sediments depends upon its chemical state and the redox potential of the sediments (Government of Canada 1994; DOI 1998). Elemental mercury in anoxic sediments is insoluble, and will

remain as elemental mercury indefinitely (Moore and Ramamoorthy 1984). Divalent mercury in anoxic sediments is reduced by bacteria to elemental mercury; divalent mercury also binds to sulfides to form insoluble mercury sulfides or binds to organic materials (Berman and Bartha 1986; D'Itri 1990). Mason and Lawrence (1998) suggest that in organic-rich estuaries such as the Litigation Area, most mercury partitions onto solid phase organic compounds, even in sediment with pore water with high sulfide concentrations. If the anoxic sediment is aerated through mixing or resuspension and becomes oxic, sulfide is oxidized to sulfate and divalent mercury ions are released (Lu and Chen 1977). These mercury ions can bind to a substrate through the following mechanisms: (1) sorption on hydrated iron oxides, (2) surface sorption or ion exchange with mineral ion exchangers such as montmorillonite, or (3) sorption with organic material such as peat, or (4) be methylated by bacteria living in the sediment (Beauford and others 1977; Moore and Ramamoorthy 1984; Government of Canada 1994; Mason and Lawrence 1998; DOI 1998).

Mercury is expected to be bound and unavailable for uptake at the Litigation Area for the following reasons: (1) most Litigation Area sediments are anoxic and rich in organic materials (sitewide average TOC greater than 100,000 mg/kg), (2) sulfide is abundant (mean of 1,998 mg/kg and range of 306 to 5,270 mg/kg) (Table 56), and (3) significant sediment mixing at the Litigation Area is not expected to occur except during major storms.

This conclusion is supported by most of the mercury BAFs calculated for clams sampled at the Litigation Area (Table 74); however, clams from one location sampled during October 2000 had a BAF of 14.2 (R01SH118), indicating that total mercury at that location is available for uptake and is being accumulated by clams. Whether this BAF is an isolated anomaly or represents sample contamination during collection and analysis is unknown.

The primary form of mercury available for uptake is methyl mercury (DOI 1998; Heinz 1996a; Thompson 1996; Wolfe and others 1998), although both inorganic and various chemical forms of organic mercury are accumulated by lower trophic level aquatic organisms such as amphipods. For example, virtually all the mercury present in fish tissues is methyl mercury (DOI 1998). Aquatic organisms can take up methyl mercury across the gills directly from water or by the ingestion of water, sediment, and prey (Luoma 1983; Carlson and others 1991; Government of Canada 1994; Mayer and others 1996). The methylation process occurs principally at the sediment-water interface (Peterle 1991; Heinz 1996a; Thompson 1996; Wolfe and others 1998). Sulfate-reducing bacteria, plankton, and perhaps other primary producers convert divalent inorganic mercury ions into methyl mercury. Because this methyl mercury is volatile, it rarely represents more than one percent of the total mercury present in the sediment (Gagnon

and others 1996). The methyl mercury is biomagnified up the food chain (Heinz 1996a; Thompson 1996; Wolfe and others 1998) with primary carnivores having mercury body burdens exceeding 1.0 mg/kg (Wolfe and others 1998). Mercury biomagnification occurs because of the extremely long half-life of mercury in animal tissues and the extremely slow excretion of mercury from the body.

In fish, no toxicosis was observed at concentrations of up to 0.33 mg/L in the diet. LC_{50} values for various fish ranged from 0.005 to 0.15 mg/L (Bartell and others 1992; Irwin and others 1998). The 48-hour LC_{50} values for various copepods ranged from 22 to 32 µg/L (EPA 1997b). Average 48-hour LC_{50} values for mollusks were 0.5 mg/L (National Library of Medicine 1996). Both dissolved and total mercury concentrations measured in October 2000 were below the DL in all ditch and slough samples (0.05 µg/L in all samples). Since the DL for mercury exceeded the chronic benchmark for total and dissolved mercury, however, there is uncertainty with respect to whether actual concentrations at the site pose a risk to aquatic biota.

5.3.3.6 Bioavailability, Bioaccumulation Potential, and Toxicity of Selenium

Sediment and soil are primary sinks for selenium at the Litigation Area (see Figure 92 for conceptual model of biogeochemical cycle). Selenium is transported into the sediments in two ways. First, selenium dissolved in water coprecipitates with iron and manganese oxides that also are dissolved in water (Newland 1982; USFWS 1987). Coprecipitation results in selenium coating an iron sold; this solid then settles by gravity in the sediment. Second, particles (typically clay or organic in nature) with adsorbed selenium also settle out of the water column into the sediment (USFWS 1987). Selenium also binds tightly to organic carbon making the selenium unavailable. Selenium does not bind to sulfides; even though Litigation Area sediment sulfide concentrations are very high, interaction between the sulfide and selenium is not expected to occur. As a result, one cannot predict selenium toxicity by measuring the acid volatile sulfide concentration present in sediment.

Selenium in the Litigation Area sediments is probably unavailable being either bound to organic carbon or precipitated on iron solids for the following reasons: (1) iron concentrations in Litigation Area sediment are high (range of 29,200 to 67,400 mg/kg, based on October 2000 samples) (Table 55), (2) sediment TOC concentrations at the Litigation Area are high (sitewide average is greater than 100,00 mg/kg), and (3) the majority of the Litigation Area sediments are anoxic.

The fate of selenium in sediment depends on whether the sediment is reduced (anoxic) or oxidized (oxic) (EPA 1992c, 1998b). In reduced sediments, the selenium-coated iron solid will remain undissolved for an indefinite period. In oxidized sediments, the iron will begin to dissolve causing some selenium to be

released in a dissolved form. When selenium desorbs from particulates or iron precipitates dissolve, the soluble selenium diffuses into the pore water and ultimately into the water column. The rate of release of selenium from sediment into the water column therefore depends on the rate at which anoxic sediments become oxidized. The principal route at the Litigation Area through which anoxic sediment would become oxidized is sediment mixing or resuspension by wind or wave action during storms. As a result, the concentrations of dissolved selenium in the Litigation Area surface water were expected to be small; indeed, no significant concentrations of selenium in surface were measured.

Selenium dissolved in water typically is present as either selenite or selenate (USFWS 1987). Dissolved selenium enters aquatic organisms across the gills (Newland 1982); benthic invertebrates and fish can also ingest particles with adsorbed selenium (Luoma 1983; Mayer and others 1996). The magnitude and significance of this route of entry is uncertain (Nalepa and Landrum 1988). Selenite is more toxic to larval and juvenile organisms than is selenate, and toxicity is most pronounced at elevated temperatures (Klaverkamp and others 1983). Selenium toxicity caused by selenium dissolved in water is rarely observed in the field (Suedel and others 1994; Kennish 1997); the LC_{50} for adult fish typically exceeds 1 mg/L (DOI 1998). Bacteria can convert inorganic into organic selenium; some higher animals can convert organic selenium into selenomethionine and similar sulfur analogs (USFWS 1987; Newland 1982; DOI 1998; EPA 1998b). These selenium-sulfur analogs are typically the source of chronic selenium toxicity in the environment (EPA 1998b). Maximum dissolved concentrations of selenium and the UCL_{95} for total selenium in surface water were all below the chronic criterion in all aquatic habitats at the Litigation Area (Table 68).

The primary cause of selenium toxicity in the field is selenium entering the food chain through accumulation; this accumulated selenium is then biomagnified up the food chain (Philips 1988, Luoma and others 1992, both as cited in Taylor and others 1992; Suedel and others 1994; Kennish 1997). Aquatic ecosystems that promote selenium accumulation and biomagnification are shallow, standing, or slow-moving waters with low flushing rates (USFWS 1987). Dissolved selenium is taken up by phytoplankton, which are consumed by crustaceans and bivalves. Crustaceans and bivalves are, in turn, prey for fish and waterfowl. Because selenium excretion is minimal, selenium concentrations may increase more than 1,000 fold from water to fish to animals (Saiki and Lowe 1987, as cited in Taylor and others 1992). Selenium was detected at a single slough location in clam tissue during October 2000 (R01SH306); a BAF of 1.65 was calculated for selenium at this location. Selenium was also detected in a single stickleback sample collected in the RASS 3 pond during 1995, yielding a BAF of 4.83.

5.3.3.7 Bioavailability, Bioaccumulation Potential, and Toxicity of Zinc

Sediment and soil are primary sinks for zinc at the Litigation Area (see Figure 89 for conceptual model of biogeochemical cycle). Zinc is transported into sediments in two ways. First, particles (typically organic in nature) with adsorbed zinc settle by gravity into the sediment (EPA 1992c). Second, zinc can coprecipitate with dissolved iron and manganese oxides resulting in a zinc-coated iron solid; the resulting solid also settles by gravity into the sediment (EPA 1992c; USFWS 1993). The behavior of zinc in sediment is primarily determined by the redox status of the sediment. In anoxic or moderately hypoxic sediment, zinc binds to sulfides forming an insoluble solid that is not available for uptake by animals and plants (Rosental and others 1986; MacDonald 1993; Newman and Jagoe 1994). SEM-AVS differences were negative in all Litigation Area sediment samples except for ditch location R01DH302 (Table 86). Total sulfide concentrations at the Litigation Area averaged 6.22×10^{-5} molar (Table 86); these concentrations are sufficiently high to bind most of the zinc measured in the Litigation Area sediment. AVS binding affinity is typically lower for zinc, however, and when the highest zinc concentrations are used in the equation for calculating the bioavailable fraction of metals, 0.45 moles of zinc are shown to be bioavailable. This finding suggests that some fraction of zinc in sediment is potentially available for uptake by aquatic biota. Sediments at the Litigation Area also contain high concentrations of organic carbon; zinc binds tightly to organic carbon, further reducing its availability.

Zinc in the Litigation Area sediments is probably unavailable being either bound to organic carbon or precipitated on iron solids for the following reasons: (1) iron concentrations in Litigation Area sediment are high (range of 29,200 to 67,400 mg/kg, based on October 2000 samples) (Table 55), (2) total sulfide concentrations in Litigation Area sediment are high (mean of 1,998 mg/kg and range of 306 to 5,270 mg/kg) (Table 56), (3) TOC concentrations in the Litigation Area sediment are high (sitewide average greater than 100,000 mg/kg), and (4) the majority of the Litigation Area sediment is anoxic.

The fate of zinc in sediment depends on whether the sediment is reduced (anoxic) or oxidized (oxic). In reduced sediment, the zinc-coated iron solid will remain undissolved for an indefinite time period. In oxic sediments, the bond between the sulfide and the zinc is often broken, releasing free zinc as divalent ions into the sediment pore water (USFWS 1993). As the soil iron begins to dissolve, zinc is released in a soluble form (Wood and others 1995). The fate of these ions is determined by pH. If the pH is low (less than six), the ions remain free and ultimately make their way into the water column as dissolved zinc. If the pH is high (greater than six), the zinc typically sorbs to particulates or other forms of organic carbon and/or forms complexes and is unavailable. Since most sediment at the Litigation Area are anoxic and pH

in more oxidized sediment is consistently higher than 6.0 (sitewide average 6.7), one would expect little zinc to diffuse into the water column.

Dissolved zinc is typically present in the water column at the Litigation Area in low concentrations, although maximum concentrations measured in some samples have exceeded both the chronic and acute surface water benchmarks. Total concentrations of zinc frequently exceeded the surface water benchmarks, often by a wide margin, in all aquatic habitats at the Litigation Area (Table 67). Measurements of dissolved zinc in surface water ranged from 0.50 to 124 µg/L (averaging 32.4 µg/L) during monitoring years 4 and 5 (Table 68). Dissolved concentrations measured during October averaged 20.52 µg/L (range of 1.3 to 101 µg/L) in ditch and slough samples (Table 57). Dissolved zinc is typically present as a divalent ion; these free ions usually enter aquatic animals across the gills (USFWS 1993; Ankley and others 1994), but benthic invertebrates and fish may also ingest particles with adsorbed zinc (Luoma 1983; Mayer and others 1996). The toxicity of zinc in fresh water varies with water hardness; increasing the water hardness decreases the zinc toxicity (Mayer and others 1994; Erickson and others 1994). Since the Litigation Area surface water had a hardness of 400 mg/L as calcium carbonate, one would anticipate that divalent metal toxicity would be somewhat mitigated. Other factors influencing zinc toxicity are pH, E_h, salinity, the presence of other complexing agents, and other antagonistic or synergistic metals (such as copper) (EPA 1991, 1992d; USFWS 1993; Eisler 1994; DOI 1998). The highest surface water concentrations of zinc measured at the Litigation Area exceed levels that are known to cause toxicity to fish and aquatic invertebrates. EPA (1997b) identified the EC_{50} (no time specified) for purple sea urchin embryos as 23.1 µg/L; for the invertebrate *Homesimysis costats*, the 21-day no-observed-effects concentration was 45 µg/L. LC_{50} values for fathead minnow ranged from 0.24 to 2.7 mg/L for 96-hour exposures, with most values above 2.0 mg/L (EPA 1997b).

Zinc is accumulated by all organisms, particularly invertebrates, but is not biomagnified up the food chain (Harvey and Luoma 1985; Hamilton and Mehrle 1986; Fowler 1987; Jamil and Hussain 1992; Eisler 1994; Suedel and others 1994; Balasubramanian and others 1995; DOI 1998). BAFs for zinc were below one at all locations where fish, tadpole, amphipod, crayfish, and damselfly larvae were sampled in 1995 (Table 76). BAFs for zinc in clam tissue exceeded one at two slough reference area locations sampled during October 2000 (SLRSH01, BAF of 1.25; SLRSH03, BAF of 1.01) (Table 74).

6.0 EXPOSURE ASSESSMENT AND EFFECTS ASSESSMENT FOR BIRDS AND MAMMALS

This section discusses the potential exposure to and effects of site contaminants on birds and mammals at the Litigation Area. Section 6.1 presents a description of bird and mammal communities, including special status species. Section 6.2 presents the approach for estimating exposure and effects using chemical doses and HQs derived from food-chain modeling for representative species identified as assessment endpoints. Section 6.3 summarizes the assessment of exposure and potential effects for birds and mammals. The risk characterization for birds and mammals is in Section 7.4.

6.1 DESCRIPTION OF BIRD AND MAMMAL COMMUNITIES

The Litigation Area sloughs, ditches, marsh surface, nontidal wetlands, and uplands provide habitat for various birds and mammals. Special status birds potentially occurring at the site are discussed in Section 6.1.2, and special status mammals are discussed in Section 6.1.4.

6.1.1 Bird Communities

At least 70 species of birds are known to forage, breed, roost, and rest in the Litigation Area, based on surveys conducted during 1995 and 1996. Complete survey data is in the after-remediation (Year 1) monitoring report (PRC 1996b).

Typical passerines of the Litigation Area include Song Sparrow (*Melospisa melodia*), Cliff and Barn Swallows (*Hirundo pyrrhonota* and *H. rustica*), Common Yellowthroat (*Geothypis trichas*), and Marsh Wren (*Cistothorus palustris*). Other common birds include Red-winged Blackbird (*Agelaius phoeniceus*), California Black Rail (*Laterallus jamaicensis coturniculus*), and Rock Dove (*Columba livia*). Ardeids and ducks typical of the sloughs include Great Blue Heron (*Ardea herodias*), Black-crowned Night Heron (*Nycticorax nycticorax*), Mallard (*Anan platyrhynchos*), and Great Egret (*Casmerodius albus*). Common raptors include White-tailed Kite (*Elanus caeruleus*), Northern Harrier (*Circus cyaneus*), Red-tailed Hawk (*Buteo jamaicensis*), and American Kestrel (*Falco sparverius*).

Winter residents of the slough, ditch, and marsh surface habitat include Yellow-rumped Warbler (*Dendroica coronata*), Semipalmated Plover (*Charadrius semipalmatus*), American Pipit (*Anthus rubescens*), Virginia Rail (*Rallus limcola*), and Common Snipe (*Gallinago gallinago*). Nocturnal and crepuscular birds include Great Horned Owl (*Bubo virginianus*), Barn Owl (*Tyto alba*), Scrub Jay (*Aphelocoma coerulescens*), and American Robin (*Turdus migratorius*).

In the RASS 3 pond and RASS 4 nontidal wetland, the most common species are Red-winged Blackbird, Mourning Dove (*Zenaida macroura*), Tree Swallow (*Tachycineta bicolor*), Song Sparrow, Marsh Wren, Virginia Rail, White-crowned Sparrow (*Zonotrichia albicollis*), and Common Yellowthroat. Ardeids and raptors that may frequent the pond area include Great Egret, American Kestrel, and Northern Harrier.

In the uplands, Rock Dove, Cliff Swallow, Song Sparrow, Barn Swallow, and Red-winged Blackbird are the most common birds. Winter residents in the upland areas of the Litigation Area include Red-winged Blackbird, House Finch, American Goldfinch, White-crowned Sparrow, Yellow-rumped Warbler, and Western Meadowlark. Other upland-associated species that were relatively common during the winter surveys were Savannah Sparrow, Song Sparrow, Golden-crowned Sparrow (*Zonotrichia atricapilla*), Loggerhead Shrike, Mourning Dove, Pine Sisken (*Carduelis pinus*), and Rock Dove. Upland-associated nocturnal species included Great Horned Owl and Barn Owl. Raptors associated with upland habitats include Red-tailed Hawk, American Kestrel, Northern Harrier, White-tailed Kite, Sharp-shinned Hawk (*Accipiter striatus*), and Golden Eagle (*Aquila chrysaetos*).

6.1.2 Special Status Birds

Special status birds in the Litigation Area include yearlong wetland and upland residents as well as seasonal migrants. Table 11 lists the special status species that potentially occur or have been observed at the Litigation Area.

6.1.2.1 California Black Rail

The California Black Rail is a year-round resident of saline, brackish, and fresh emergent wetlands of Suisun Bay, San Francisco Bay, and the Sacramento delta. The Black Rail is listed by the State of California as threatened because of a substantial decline in population and distribution of this species (CDFG 2001), primarily as a result of habitat loss (Goals Project 1999). California Black Rail Surveys were conducted at the Litigation Area each year during the 5 years of postremediation monitoring (TtEMI 2000a). The Black Rail population estimate for the Litigation Area during 1999 (120 birds) represents a 10-fold increase in the number of rails counted since the 1991 preremediation survey, when approximately 10 birds were estimated to reside in the Litigation Area. Statistical analyses indicated a significant increase in rail numbers during the 5-year period (Appendix D). The increase in population may be attributed to a return to more normal rainfall patterns and subsequent growth of marsh vegetation since 1991. Most rails were detected in stands of *Typha* and *Scirpus*; both of these marsh species have shown increased coverage during the past few years. Rails are located mainly in dense vegetation, but are not associated with the mosquito ditches (Appendix D).

6.1.2.2 California Clapper Rail

The California Clapper Rail (*Rallus longirostris obsoletus*) is a state and federal endangered species that occurs in emergent salt and brackish tidal marshlands of San Francisco Bay (Goals Project 2000). Two individuals were detected at the Litigation Area: one in 1995 and one in 1996. Since that time, no clapper rails have been detected at the site. The Clapper Rail's preferred habitat, salt marsh with channels and stands of *Spartina,* does not occur in the Litigation Area. Clapper Rails detected during 1995 to 1996 are believed to represent transitory, unmated males moving through the area. Clapper Rail surveys were discontinued after 1996.

6.1.2.3 Other Special Status Bird Species

The Saltmarsh Common Yellowthroat (a federal candidate species) may occur at the Litigation Area, but it's presence at the Litigation Area has not been confirmed; further delineation would be required to confirm the subspecies' range (PRC 1996b). Similarly, the Suisun Song Sparrow (*Melospisa melodia maxillaries*), a federal and state subspecies of concern, is assumed present, although it cannot be conclusively distinguished from the other subspecies of song sparrow in the Litigation Area (PRC 1996b). The Western Snowy Plover (*Charadrius alexandrinus*) is a federally threatened species that has been observed at the Litigation Area (Table 12); Western Snowy Plovers occur in Suisun Bay only rarely (Goals Project 2000).

Raptors and ardeids of special status observed at the Litigation Area include the California Brown Pelican (a state and federally listed endangered species), Double-crested Cormorant (a California species of special concern), White-faced Ibis (a federal and state species of special concern), Northern Harrier (a California species of special concern), and Peregrine Falcon (a state listed endangered species). All of these species, with the exception of the Northern Harrier, are expected to be only transient visitors to the Litigation Area. As a year-round resident, the Northern Harrier was chosen as a representative receptor for food-chain modeling. The Short-eared Owl (*Asio flammeus*) has been sighted occasionally in the salt marshes at NWSSBD Concord (Jones and Stokes 1982; PRC 1996b).

6.1.3 Mammal Communities

Mammals known to occur in the Litigation Area are described below. Special status mammals are described in Section 6.1.4.

Upland and wetland mammal populations were characterized from a review of the 1994 wildlife survey of NWSSBD Concord (Morrison and others 1994), records of incidental observations made while

conducting other Litigation Area activities in recent years, and the postremediation monitoring small mammal surveys (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a).

Mammals common in the wetlands of the Litigation Area include small herbivores such as the salt marsh harvest mouse (*Reithrodontomys raviventris*) and California vole (*Microtus californicus*); small- to medium-sized omnivores such as the western harvest mouse (*Reithrodontomys megalotis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*). Larger predators include the carnivorous river otter, the native gray fox, and the introduced red fox (*Vulpes vulpes*).

Mammals likely use the RASS 3 pond and the RASS 4 nontidal wetlands for drinking, bathing, and foraging. The proximity of roads and human activity may limit the use of nontidal wetlands by larger, more mobile mammals. Mammals expected to occur in nontidal wetlands include the Virginia opossum (*Didelphis marsupialis*), deer mouse (*Peromyscus maniculatus*), western harvest mouse, striped skunk, and coyote (*Canis latrans*).

Small mammals species observed in the uplands include the western harvest mouse (a close relative of the salt marsh harvest mouse), California vole, house mouse (*Mus musculus*), and deer mouse. Large mammals observed in the uplands include gray fox, red fox, and coyote. Other mammals observed in and around the uplands include California ground squirrel (*Spermophilus beecheyi*), black-tailed jackrabbit (*Lepus californicus*), striped skunk, and Virginia opossum (Morrison and others 1994).

6.1.4 Special Status Mammals

One federal and state endangered mammal, the salt marsh harvest mouse, is known to use the tidal marsh of the Litigation Area (TtEMI 2000a). Salt marsh harvest mouse populations at the Litigation Area have been monitored each year during post remediation monitoring. A total of 33 salt marsh harvest mice were captured at the Litigation Area during small mammal trapping in 1999; more mice were caught in 1999 than in previous years. Based on vegetation characterization of small mammal trap locations, the preferred vegetation for the salt marsh harvest mouse is pickleweed, saltgrass, and Baltic rush (TtEMI 2000a). The salt marsh harvest mouse has recolonized remediated areas in RASS 1, which indicates that the restoration efforts have provided suitable habitat for this species.

6.2 FOOD-CHAIN MODELING AND HAZARD QUOTIENTS

The evaluation of risk to birds and mammals focused on selected assessment endpoints identified in Section 2.0, and ingestion of chemicals in soil, sediment, and prey as the major exposure route. Site-specific estimated doses were compared with TRVs derived from peer-reviewed literature studies in

an HQ approach. A TRV is a daily dose level derived from reported biological effects on laboratory animals. Risk to representative birds and mammals at the Litigation Area was evaluated quantitatively based on a HQ approach where the dose was divided by the TRV.

TRVs were derived for COPECs and receptors specific to Navy installations in a collaborative effort involving the Navy and its contractors and the EPA Region IX Biological Technical Assessment Group (BTAG). BTAG includes federal, state, and local regulatory agencies and resource trustees. The derivation of TRVs and the use of food-chain analysis in the HQ approach were described in detail in a technical memorandum (EFA West 1998).

Food-chain analysis was conducted for the six inorganic COPECs (arsenic, cadmium, copper, lead, selenium, and zinc), mercury in pond and slough habitat units, and total DDTs, total PCBs, and total Aroclors. Ingestion of contaminants in soil, sediment, and prey was considered the most important exposure pathway for vertebrate receptors. Based on site-specific chemical concentrations, the contribution of surface water to the total daily dose was considered negligible, and not included in the calculations.

Uncertainty associated with excluding inhalation and dermal routes of exposure is addressed in Section 7.6.

Representative receptors selected for food-chain modeling are the same species that were used in the QEA (PRC 1997b). Avian receptors include Suisun Song Sparrow, Black Rail, Northern Harrier, American Kestrel, Mallard, and Great Blue Heron. Mammalian receptors include the salt marsh harvest mouse, gray fox, and river otter. Selection of these species was based on assessment endpoints identified in Table 50, the CSM (Figures 16 through 20), and agreements with regulatory and trustee agencies. Habitat areas and spatial units at the site that were considered appropriate exposure units were identified for each receptor (Tables 98 through 106).

Section 6.2.1 discusses the exposure assessment, including estimates of site-specific doses using food-chain models. Section 6.2.2 summarizes the exposure parameters used in the food-chain model. The dose parameters for each representative receptor are summarized in Section 6.2.3. Section 6.2.4 summarizes the TRVs used and the HQ approach. Dose estimates for birds and mammals are discussed in Section 6.3.

6.2.1 Food-chain Model

Food-chain modeling integrates ecological information such as life history and feeding behavior of receptors and spatial variation in chemical concentrations in prey and soil into the risk assessment. Estimates of site-specific exposures for higher-trophic-level organisms were based on daily dose estimates modeled from measurements of chemical concentrations in soil or sediment and food sources (Pascoe and others 1994, 1996; Pastorok and others 1996).

Site-specific doses were calculated as the sum of the daily dietary exposure estimates for ingestion of food items and incidentally ingested sediment. The following equation was adapted for each receptor:

$$Dose_{total} = \frac{\left(\left[IR_{prey} \times C_{prey}\right] + \left[IR_{soil} \times C_{soil}\right]\right) \times SUF}{BW} \qquad (6\text{-}1)$$

where:

$Dose_{total}$	=	Estimated dose from ingestion (mg/kg body weight per day)
IR_{prey}	=	Ingestion rate of prey (kilograms per day [kg/day])
C_{prey}	=	Concentration of chemical in prey (mg/kg)
IR_{soil}	=	Ingestion rate of soil (kg/day)
C_{soil}	=	Concentration of chemical in soil (mg/kg)
SUF	=	Site use factor (unitless), which is a ratio of site-specific area to receptor's foraging range (unitless)
BW	=	Body weight (kilogram) of receptor

Exposure assumptions were tailored to conditions at the Litigation Area to reduce uncertainty. Nevertheless, sources of uncertainty may result from assumptions concerning bioavailability, diet proportions of receptors, food-chain transfer, and other biological and physical factors and processes influencing exposure and toxicity at the site. Estimates of doses used values from relevant literature based on habitat, taxa, exposure route, and other ecological factors.

6.2.2 Exposure Parameters in the Dose Model

Exposure models for birds and mammals are based on the assumption that exposure to chemicals is primarily through direct ingestion of prey and incidental ingestion of sediment and soil during grooming, feeding, or burrowing activities (Beyer and others 1994). Exposure models estimate the mass of a chemical ingested daily by a receptor per kilogram of body weight (daily chemical dose). Estimates of exposure are generally based on knowledge of the spatial and temporal distribution of both chemicals and

receptors and on specific natural and life history characteristics that influence exposure to chemicals. All doses calculated in the BERA were based on a typical receptor and incorporated the following life history parameters:

- The *average* adult body weight found in the literature
- The *average* ingestion rate or the *average* adult body weight found in the literature to calculate the ingestion rate, using the appropriate equation from Nagy and others (1999)
- A reasonable estimate of site use factor (SUF) based on literature evaluation.

Chemical concentrations in soil and prey used in the food-chain models are discussed in the following sections.

6.2.2.1 Concentrations of Organic Chemicals in Prey and Sediment

A screening-level approach to evaluating risk to birds and mammals from organic chemicals was used in this report. Total DDT, total PCBs, and total Aroclors were evaluated based on agreements with regulatory and trustee agencies. Table 87 presents a summary of the approach used for evaluating risk to birds and mammals for organic chemicals.

Because DLs for organic chemicals were elevated, two doses were calculated for each receptor:

1. A worst-case scenario dose in which the full DL was substituted for ND values (full DL dose)
2. A more realistic estimate using one-half the DL as a substitute for ND data (1/2 DL dose).

All organic chemical doses calculated were based on screening-level assumptions and incorporated the following parameters:

- The *maximum* sediment or soil concentration
- The *maximum* prey tissue concentration

The maximum soil or sediment concentration for organic chemicals is defined as the highest concentration in an individual exposure unit; in most cases, the maximum was actually the DL substitution rather than a detected concentration. Two maximum concentrations for each organic chemical were evaluated (full DL and 1/2 DL), as described above.

No site-collected tissue concentrations were available for some of the organic chemicals; in those cases, literature-derived BAFs (EPA 1999) and maximum soil or sediment concentrations were used to estimate a tissue concentration (BAF × maximum sediment concentration = estimated tissue concentration). The uncertainty associated with using literature-derived tissue concentrations is discussed in Section 7.6.

6.2.2.2 Concentrations of Inorganic Chemicals in Prey and Sediment

Soil and sediment data from the QEA (PRC 1997b) and 5 years of postremediation monitoring were used in the dose calculations (PRC 1996b, 1997a; TtEMI 1998, 1999, 2000a). Tissue residue data were from the baseline conditions report (PRC 1994), QEA, and recent October 2000 clam sampling event were also used in dose calculations.

Risk to most receptors (Suisun Song Sparrow, Northern Harrier, American Kestrel, Mallard, Great Blue Heron, river otter, and gray fox) was estimated using a two-tiered approach to dose modeling. In tier 1, chemical doses were calculated based on UCL_{95} sediment and tissue concentrations. The UCL_{95} is defined as the UCL_{95} of the areawide mean (grand mean of all location means) within an exposure unit (Table 88).

In cases where three or fewer tissue samples were available, the maximum tissue concentration was used in the dose rather than the UCL_{95}. Doses calculated in tier 1 were compared with high and low TRVs. Any dose that exceeded the high TRV was carried through to tier 2. In tier 2, dose models were calculated using the mean soil and mean tissue concentrations compared with the high TRV to provide a more refined estimate of risk.

Risk to the two threatened or endangered species at the site (salt marsh harvest mouse and Black Rail) was based on area doses calculated using upperbound sediment and tissue concentrations, resulting in dose estimates protective of individual animals. These higher dose estimates included the following parameters:

- The lower of the *Maximum* or *99th percentile* sediment or soil concentration. Maximum or 99th percentile concentrations in this context represent the maximum or 99th percentile 5-year average calculated for an individual location within an exposure unit. All subsequent references to maximum or 99th percentile concentrations for inorganic chemicals in soil or sediment refer to this definition.

- The *Maximum* tissue concentration.

For all receptors, one half the DL was substituted in the dose for ND inorganic chemicals.

6.2.3 Dose Parameters for Representative Receptors

The values and rationale for the selection of parameters in the dose model are presented in the following sections for each representative receptor.

6.2.3.1 Dose Parameters for the Black Rail

The Black Rail is a representative species of carnivorous shorebirds and wading birds. Due to its threatened status, conservative dose parameters were used for the Black Rail to provide greater protection for individuals. The habitats modeled for the Black Rail were the RASS 1 ditches (organic chemicals) and main slough (inorganic chemicals) (Tables 87 and 88). The parameters used in dose calculations for the Black Rail (Table 89) included:

- **Body Weight:** The body weight selected (0.029 kilograms) represents a mean body weight of male and female Black Rails (Eddleman and others 1994).

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using a body weight from the literature (as described above) in an equation for dry weight daily food intake for all birds (Nagy and others 1999). The average Black Rail body weight yielded a prey ingestion rate of 0.00578 kg/day.

- **Prey Composition:** The Black Rail diet is composed of mostly terrestrial insects but also includes aquatic invertebrates and seeds of aquatic vegetation (Erlich and others 1988). Sampling of rail habitats in North San Francisco Bay marshes indicated arachnids and amphipods as likely prey items (Goals Project 2000). For this assessment, a diet of 100 percent amphipods was assumed. No amphipod tissue from the site was analyzed for DDTs, PCBs, or Aroclors; therefore, amphipod prey concentrations for the organic doses are based on literature-derived BAFs and maximum sediment concentrations from the site, as presented in Table 89. Because of the uncertainty associated with literature-derived BAFs, an additional dose was calculated for organic chemicals, assuming a diet of 100 percent clams. All clam tissue concentrations are based on site-collected data. The maximum tissue concentration for each COPEC was used in both the organic and inorganic chemical dose models.

- **Ingestion Rate$_{sediment}$:** No information on the ingestion rate of sediment was available in the literature for Black Rails. The Black Rail ingestion rate for sediment was estimated to be similar to that of the sandpiper, or 18 percent of the prey ingestion rate (Beyer and others 1994).

- **SUF:** According to Zeiner and others (1990), the average foraging range for Black Rails is 120 hectares. RASSs 1 to 3 of the Litigation Area are about 119 hectares. A SUF of 1.0 was assumed.

6.2.3.2 Dose Parameters for the Suisun Song Sparrow

The Suisun Song Sparrow was selected to be representative of carnivorous passerines in the Litigation Area. Area doses were calculated for the Suisun Song Sparrow based on site-collected sediment and tissue data from the marsh surface. Only inorganic doses were calculated for the sparrow, based on agreements with regulatory and trustee agencies. The habitat modeled for the Song Sparrow was the main slough (Table 88). The parameters used in dose calculations for the Suisun Song Sparrow (Table 90) include:

- **Body Weight:** The body weight selected (0.0235 kilograms) represents a mean body weight of male and female Song Sparrows (Dunning 1993).

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using a body weight from the literature (as described above) in an equation for dry weight daily food intake for passerines (Nagy and others 1999). Using an average sparrow body weight yielded a prey ingestion rate of 0.048 kg/day.

- **Prey Composition:** The Suisun Song Sparrow diet is composed of seeds, insects, spiders, crustaceans, and mollusks (Zeiner and others 1990). For this assessment, two diet scenarios were modeled: a diet of 50 percent amphipods and 50 percent plants, and a diet of 100 percent amphipods. The maximum concentrations of site-collected amphipods and UCL_{95} concentrations of plants were used in the doses.

- **Ingestion Rate$_{sediment}$:** The ingestion rate of sediment was estimated to be 8 percent of the prey ingestion rate, based on a study of ash in the diet of a Song Sparrow (Williams 1987).

- **SUF:** According to Johnston (1968), the territory size of a salt marsh Song Sparrow is 0.04 hectare. Because each unit evaluated in the BERA is larger than 0.4 hectare, a SUF of 1.0 was assumed for the dose.

6.2.3.3 Dose Parameters for the Mallard

The Mallard was selected to be representative of aquatic avian omnivores in the Litigation Area. Because mallards have been observed in the pond and sloughs of the Litigation Area, two doses were calculated based on potential prey in the pond habitat and the slough habitat (Tables 87 and 88). The parameters used in dose calculations for the Mallard (Table 91) include:

- **Body Weight:** The body weight selected (1.16 kilograms) represents a mean body weight of male and female mallards in North America (Heitmeyer 1988). Body weight for Mallards of both sexes reported in the literature ranged from 0.98 kilogram (Heitmeyer 1988) to 1.8 kilograms (Nelson and Martin 1953).

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using a body weight from the literature (as described above) in an equation for dry weight daily food intake for all birds (Nagy and others 1999). Using an average Mallard body weight yielded a prey ingestion rate of 0.09 kg/day.

- **Prey Composition:** Mallards are opportunistic in their foraging behavior. In the Suisun Marsh, the Mallard diet is composed of aquatic plants such as alkali bulrush, fat hen, brass buttons, watergrass, and smart weed; insects; and aquatic invertebrates (Goals Project 2000; Ehrlich and others 1988). A diet comprised of animals is especially important for females during breeding season and for ducklings. For this assessment, a diet of 50 percent damselfly larvae, 12.5 percent stickleback, 12.5 percent tadpoles, and 25 percent plants was assumed for Mallards in the pond, and a diet of 75 percent sculpin and 25 percent plants was assumed for Mallards in the slough. For the organic and inorganic chemical doses, maximum site-collected damselfly, stickleback, sculpin, and tadpole concentrations were used. UCL_{95} plant concentrations were used in the inorganic chemical doses. Because no plant tissues analyzed for organic chemicals were available, plant tissue concentrations were estimated using literature-derived BAFs, as summarized in Table 91.

- **Ingestion Rate$_{sediment}$:** The Mallard ingestion rate for sediment was estimated to be 3.3 percent by Beyer and others (1994), based on acid-insoluble ash of scat samples and assumed digestibility of the diet.

- **SUF:** According to Zeiner and others (1990), the foraging distance from the nest during the breeding season ranges from 3 to 8 square kilometers (300 to 800 hectares). The Litigation Area is more than 300 acres; therefore, a SUF of 1.0 was used for all Mallard doses.

6.2.3.4 Dose Parameters for the Great Blue Heron

The Great Blue Heron was selected to be representative of piscivorous birds that inhabit the Litigation Area. Area doses were calculated for the Great Blue Heron using site-collected sediment and tissue data from the slough and the RASS 3 pond. The habitats modeled for the heron were the main slough and RASS 3 pond (Tables 87 and 88). The parameters used in dose calculations for the Great Blue Heron (Table 92) include.

- **Body Weight:** The body weight selected (2.39 kilograms) represents a mean body weight of male and female Great Blue Herons (Dunning 1993).

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using a body weight from the literature (as described above) in an equation for dry weight daily food intake for fish-eating birds (Nagy and others 1999). Using an average Great Blue Heron body weight yielded a prey ingestion rate of 0.13 kg/day.

- **Prey Composition:** The Great Blue Heron diet is composed mainly of fish; however, small rodents, amphibians, insects, crustaceans, snakes, and lizards are also consumed (Zeiner and others 1990). For this assessment, a diet of 100 percent fish was assumed in the slough and a diet of 80 percent fish, 10 percent crayfish, 10 percent tadpoles, and 5 percent rodents was assumed in the RASS 3 pond area. Maximum concentrations of site-collected fish, tadpole, and crayfish were used in the doses. No rodent tissue data from the site were analyzed for DDTs, PCBs, or Aroclors; as a result, rodent prey concentrations for organic doses were based on literature-derived BAFs and maximum sediment concentrations from the site, as presented in Table 92.

- **Ingestion Rate$_{sediment}$:** No information on the ingestion rate of sediment was available in the literature for Great Blue Herons. The Great Blue Heron ingestion rate for sediment was estimated to be similar to that of the Mallard (3.3 percent of the prey ingestion rate) (Beyer and others 1994).

- **SUF:** According to Bayer (1993), as cited in EPA (1993), the size of a Great Blue Heron feeding territory in an Oregon freshwater marsh and estuary ranged from 1.5 to 20 hectares. The sloughs of the Litigation Area cover more than 300 acres and the RASS 3 pond is approximately 1 hectare. Therefore, a SUF of 1.0 was assumed for the slough and a SUF of 0.5 was assumed for the pond.

6.2.3.5 Dose Parameters for the Northern Harrier

The Northern Harrier was selected to be representative of carnivorous raptors. The harrier is a year-round resident of the Litigation Area uplands and marsh surface (PRC 1996b) and is a California species of special concern. The habitats modeled for the harrier were the RASS 3 and 4 uplands (organic chemicals) and RASS 1 through 3, RASS 4, and Unit 8 (inorganic chemicals) (Tables 87 and 88). The parameters used in dose calculations for the Northern Harrier (Table 94) include:

- **Body Weight:** The body weight selected (0.441 kilograms) represents a mean body weight of male and female harriers (Dunning 1993).

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using a body weight from the literature (as described above) in an equation for dry weight daily food intake for all birds (Nagy and others 1999). Using an average Northern Harrier body weight yielded a prey ingestion rate of 0.0369 kg/day.

- **Prey Composition:** The Northern Harrier diet is composed mainly of rodents, but may also include birds, frogs, small reptiles, crustaceans, and insects (Temeles 1989; Brown and Amadon 1968). For this assessment, a diet of 100 percent rodents was assumed. A UCL_{95} of site-collected rodent kidney and liver tissue was used in the inorganic doses. No rodent tissue data from the site were analyzed for DDTs, PCBs, or Aroclors; therefore, rodent prey concentrations organic doses are based on literature-derived BAFs and maximum sediment concentrations from the site, as presented in Table 94.

- **Ingestion Rate$_{sediment}$:** No information on the ingestion rate of sediment was available in the literature for Northern Harriers. The Northern Harrier ingestion rate for sediment is estimated to be similar to that of the Bald Eagle (0.7 percent of the prey ingestion rate) (Pascoe and others 1996).

- **SUF:** According to EPA (1993), the home range for Northern Harriers ranges from 12 to 259 hectares. RASSs 1 to 3 of the Litigation Area are about 119 hectares, RASS 4 is 5.3 hectares, and Unit 8 is 7.6 hectares. A SUF of 1.0 was assumed for RASSs 1 to 3, and an SUF of 0.1 was assumed for RASS 4 and Unit 8.

6.2.3.6 Dose Parameters for the American Kestrel

The American Kestrel was selected to be representative of carnivorous raptors. The kestrel is a year-round resident of the Litigation Area uplands and marsh surface (PRC 1996b). The habitats modeled for the kestrel were RASS 1 through 3, RASS 4, and Unit 2 (Table 88). The parameters used in dose calculations for the American Kestrel (Table 93) include:

- **Body Weight:** The body weight selected (0.119 kilogram) represents a mean body weight of male and female kestrels (Roest 1957).

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using a body weight from the literature (as described above) in an equation for dry weight daily food intake for all birds (Nagy and others 1999). Using an average American Kestrel body weight yielded a prey ingestion rate of 0.0151 kg/day.

- **Prey Composition:** The American Kestrel diet is composed mainly of small mammals, but may also include birds, insects, earthworms, reptiles, and amphibians (Zeiner and others 1990). For this assessment, a diet of 100 percent rodents was assumed. A UCL_{95} of site-collected rodent kidney and liver tissue was used in doses.

- **Ingestion Rate$_{sediment}$:** No information on the ingestion rate of sediment was available in the literature for American Kestrels. The American Kestrel ingestion rate for sediment is estimated to be similar to that of the Bald Eagle (0.7 percent of the prey ingestion rate) (Pascoe and others 1996).

- **SUF:** According to EPA (1993), the average home range for American Kestrels is 109.4 hectares. RASSs 1 to 3 of the Litigation Area are about 119 hectares, RASS 4 is 5.3 hectares, and Unit 8 is 7.6 hectares. A SUF of 1.0 was assumed for RASSs 1 to 3, and an SUF of 0.1 was assumed for RASS 4 and Unit 8.

6.2.3.7 Dose Parameters for the Salt Marsh Harvest Mouse

The salt marsh harvest mouse is an endangered species that is present in the tidal marsh of RASS 1 at the Litigation Area (TtEMI 1999). Food and incidentally ingested soil are likely to be the major routes of exposure to chemicals for the salt marsh harvest mouse. Because the salt marsh harvest mouse is an

endangered species, maximum concentrations were used in the doses to provide a conservative estimate of risk. Area doses were calculated for each chemical based on site-collected tissue and sediment data from each of the marsh surface areas (Units 1, 2, 4, 6, and 8) (Tables 87 and 88). The parameters used to estimate site-specific doses for the salt marsh harvest mouse (Table 95) include:

- **Body Weight:** An average male and female body weight of 0.0105 kilogram was recorded from salt marsh harvest mice trapped at the Litigation Area (H.T. Harvey and Associates 1996). This average body weight was used in all doses.

- **Ingestion Rate$_{prey}$:** An average prey ingestion rate of 0.00265 kg/day was calculated using an average body weight from salt marsh harvest mice caught at the Litigation Area (as described above) and a measured prey ingestion rate from the literature (Fisler 1963).

- **Prey Composition:** According to Zeiner and others (1990), salt marsh harvest mice eat 100 percent vegetation, including seeds and plants. The diet composition for the salt marsh harvest mouse was assumed to be 100 percent pickleweed (green tissue). The maximum site-collected pickleweed tissue residue concentrations were used in the inorganic chemical doses. No site-collected pickleweed data were analyzed for total DDTs, total PCBs, or total Aroclors. Therefore, literature-derived BAFs and maximum sediment concentrations were used to estimate concentrations of organic chemicals in pickleweed tissue, as presented in Table 95.

- **Ingestion Rate$_{sediment}$:** The salt marsh harvest mouse ingestion rate for sediment was assumed to be similar to that of a meadow vole. The estimated sediment ingestion rate for meadow voles studied by Beyer and others (1994) was 2.4 percent of the total prey ingestion rate. In the same study, the sediment ingestion rate for white-footed mice was estimated at 2 percent. The higher rate of 2.4 percent of the prey ingestion rate was used to calculate sediment ingestion rates for the salt marsh harvest mouse; the sediment ingestion rate was 0.0000635 kg/day.

- **SUF:** According to Golley and others (1975), the home range of harvest mice ranges from 0.16 to 0.26 hectare. The dose estimates were based on a SUF of 1.0 for the mouse.

6.2.3.8 Dose Parameters for the Gray Fox

The gray fox was selected to represent terrestrial carnivorous mammals at the Litigation Area. Exposure of the gray fox was modeled for inorganic chemicals only, based on agreements with the regulatory and trustee agencies. Area doses were calculated for each inorganic chemical based on site-collected tissue and soil data from RASSs 1, 2, and 3; RASS 4; and Unit 8 (Table 88). The parameters used to estimate site-specific doses for the gray fox (Table 96) include:

- **Body Weight:** An average gray fox male and female body weight of 4.4 was used in all doses (Silva and Downing 1995).

- **Ingestion Rate$_{prey}$:** An average prey ingestion rate of 0.177 kg/day was calculated using an average body weight from the literature (as describe above) in an equation for dry weight daily food intake for all mammals (Nagy and others 1999).

- **Prey Composition:** According to Palmer and Fowler (1975), as cited in EPA (1993), gray fox eat mainly mice and voles, but also eat other small mammals, insects, hares, game birds, poultry, and occasionally seeds, berries, and fruits. The diet composition for the gray fox was assumed to be 100 percent rodent. The UCL_{95} of site-collected rodent kidney and liver tissues was used in the inorganic chemical doses.

- **Ingestion Rate$_{soil}$:** The gray fox ingestion rate for soil was assumed to be similar to that of red fox. The estimated sediment ingestion rate for red fox studied by Beyer and others (1994) was 2.8 percent of the total prey ingestion rate. That estimate was used to calculate a typical soil ingestion rate of 0.004956 kg/day.

- **SUF:** According to Zeiner and others (1990), the average home range of the gray fox is 120 hectares. RASSs 1 through 3 of the Litigation Area are about 119 hectares, RASS 4 is 5.3 hectares, and Unit 8 is 7.6 hectares. Dose estimates were based on a SUF of 0.25 for the fox for all areas.

6.2.3.9 Dose Parameters for the River Otter

The river otter was selected to represent aquatic carnivorous mammals at the Litigation Area. Estimated doses of organic and inorganic COPECs, including mercury, from the slough habitat were calculated. An areawide dose was calculated for each chemical based on site-collected tissue and sediment data from the slough (Tables 87 and 88). The parameters used estimate site-specific doses for the river otter (Table 97) include:

- **Body Weight:** An average male and female river otter body weight of 5.0 kilograms was used in all doses (EPA 1993).

- **Ingestion Rate$_{prey}$:** An average prey ingestion rate of 0.215 kg/day was calculated using an average body weight from the literature (as describe above) in an equation for dry weight daily food intake for mammals (Nagy and others 1999).

- **Prey Composition:** According to Modafferi and Yocam (1980), as cited in EPA (1993), river otters in Northern California eat mainly fish and aquatic invertebrates (such as crabs), but also eat birds, dragonflies, ostracods, and snails. Otters appear to have been feeding on clams at the Litigation Area (Mary Gleason, TtEMI, personal observation). Two diet scenarios for the otter were used in the doses: 100 percent clams and 100 percent fish. The UCL_{95} and maximum concentrations of chemical in site-collected clam and fish tissues were used in the inorganic and organic chemical doses.

- **Ingestion Rate$_{soil}$:** The river otter ingestion rate for soil was assumed to be similar to that of mink. The estimated sediment ingestion rate for mink studied by Pascoe and others (1996) was 1 percent of the total prey ingestion rate. That estimate was used to calculate a typical soil ingestion rate of 0.00215 kg/day.

- **SUF:** According to Foy (1982), as cited in EPA (1993), the average home range of river otters ranges in a Texas coastal marsh ranged from was 323 hectares. Dose estimates were based on a SUF of 0.25 for the river otter.

6.2.4 Toxicity Reference Values and Hazard Quotient Interpretation

Site-specific daily dose estimates were compared with high and low TRVs to estimate the potential adverse biological effects on each receptor. Based on this comparison, the risk to representative receptors was characterized; this comparison was performed in a manner consistent with EPA's HQ methodology (EPA 1998a), as follows:

$$HQ = \frac{Dose}{TRV} = \frac{(mg / kg - day)}{(mg / kg - day)} \tag{6-2}$$

where:

HQ	=	Hazard quotient (unitless)
Dose	=	Chemical-, receptor-, and site-specific daily dose estimate (mg/kg per day [mg/kg-day])
TRV	=	Chemical- and receptor-specific toxicity reference value (mg/kg-day)

6.2.4.1 Toxicity Reference Values

All TRVs used in the BERA were derived from the Navy-BTAG working group (EFA West 1998). Each TRV represents a critical exposure level from a toxicological study and is supported by a data set of toxicological exposures and effects. A low TRV is a conservative value consistent with a chronic no effect level. A high TRV represents a mid-range of lowest-observable–adverse-effects levels for a given chemical, where the endpoint of toxicity was ecologically relevant. TRVs were derived separately for birds and mammals using available toxicological literature in a consensus process.

General TRVs derived for mammals and birds were adjusted for each site-specific receptor of concern based on body scaling (allometric conversion). The underlying assumption of allometric conversion is that physiological functions, such as metabolic rates, are a function of body size (Opresko and others 1993). Allometric conversions assume that smaller animals have higher metabolic rates and are typically able to detoxify or eliminate ingested chemicals more quickly than larger animals (Opresko and others

1993; Sample and others 1996). The following allometric conversion equations by Sample and Arenal (1999) were used for this food-chain model:

Birds $TRV_{receptor} = TRV_{test\ organism}\ (Body\ Weight_{test\ organism} / Body\ Weight_{receptor})^{1 - 1.2}$

Mammals $TRV_{receptor} = TRV_{test\ organism}\ (Body\ Weight_{test\ organism} / Body\ Weight_{receptor})^{1 - 0.94}$

TRVs for each chemical, allometrically converted for each of the representative receptors using the appropriate equation for birds or mammals, are presented in a TRV technical memorandum (EFA West 1998).

6.2.4.2 Hazard Quotient Approach

Risk to the receptors was characterized by calculating an HQ from the typical dose modeled for each receptor and chemical and a literature-derived TRV. The dose estimates were divided by the high TRV and the low TRV, resulting in two HQs for each chemical-receptor pair that bound the range of risks identified by this method (EFA West 1998). As explained in EPA regulatory guidance (EPA 1989), the HQ approach indicates that receptors may be at risk if the HQ exceeds 1.0. Because of differences in the degree of conservatism in selection of TRVs for various chemicals and receptors, resulting HQ values should not be compared between chemicals or receptors or summed in a hazard index; instead, they should be considered individually.

Tables 111 and 112 present the WOE approach for characterizing risk to birds and mammals for organic and inorganic chemicals. The worst-case scenario is represented when the $HQ_{(Dose/high\ TRV)}$ is greater than 1.0. In the worst-case scenario, the receptor may be at unacceptable risk from that chemical if all assumptions of the model are correct. The high TRV represents the low to mid-range of doses that caused observable effects in laboratory animals.

The minimal risk scenario is represented when the HQ calculated using the dose and the low TRV ($HQ_{dose/low\ TRV}$) is less than or equal to 1.0. A $HQ_{(dose/low\ TRV)}$ less than 1.0 indicates no risk from exposure of that receptor to that chemical. Low TRVs represent a concentration at which no adverse effects were observed in laboratory animals.

Risk posed by site-specific dose estimates that range between the low and high TRVs cannot be easily characterized. In those cases, the potential risk to the receptor was evaluated in the context of toxicological literature that the TRV is based on.

The interpretation of each HQ is summarized in the following table.

HQ = Dose/TRV	Low TRV	High TRV
Dose	$HQ_{(dose/low\ TRV)}$ less than 1.0 indicates little or no risk to typical receptor	$HQ_{(dose/high\ TRV)}$ greater than 1.0 indicates unacceptable risk to typical receptor

6.3 RESULTS OF EXPOSURE AND EFFECTS ASSESSMENT

Food-chain analysis and literature reviews were used to evaluate the potential effects of chemicals on birds and mammals. Using site-specific prey tissue concentrations, this type of food-chain analysis provides a relatively good estimate of dose for those receptors and chemicals for which data are available. The results of the food-chain modeling are presented in this section. The complete dose calculations are provided in Tables G4-1 through G4-15 in Attachment G4. Results are provided in embedded tables throughout this section and summarized in risk characterization (Section 7.4).

6.3.1 Risk to Birds from Organic Chemicals

Areawide doses for total DDTs and total PCBs and Aroclors were calculated for the Black Rail, Great Blue Heron, Mallard, and Northern Harrier for the habitat units presented in Table 87. Two doses were calculated for each receptor: one using the DL as a substitute for ND data (full DL dose) and one using one-half the DL as a substitute for ND data (1/2 DL dose).

Daily dose estimates for each receptor and chemical were then compared with low and high TRVs to calculate HQs; these calculations are presented in their entirety in Table G4-1 through G4-4 in Attachment G4. For the Northern Harrier and Great Blue Heron, no HQs indicated risk from total DDT or total PCBs and Aroclors at the site (all $HQs_{[dose/low\ TRV]}$ were less than 1.0) (Tables 103 and 101). Receptors with HQs greater than 1.0 are presented below.

Organic COEC	Diet	Dose Type	Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (Dose/Low TRV)	HQ (Dose/High TRV)
Black Rail in Ditches							
Total DDTs	Amphipod*	1/2 DL	0.026	0.003	0.739	**14.84**	0.07
		Full DL	0.053	0.003	0.739	**29.68**	0.14
	Clam	1/2 DL	0.008	0.003	0.739	**2.33**	0.01
		Full DL	0.024	0.003	0.739	**6.81**	0.03
Total PCBs and Aroclors	Amphipod*	1/2 DL	0.417	0.003	0.739	**18.45**	**1.19**
		Full DL	0.827	0.003	0.739	**36.89**	**2.38**
	Clam	1/2 DL	0.050	0.003	0.739	**1.19**	0.08
		Full DL	0.124	0.003	0.739	**2.93**	0.19
Mallard in Pond							
Total DDTs	Damselfly larvae, stickleback, tadpoles, and plants*	1/2 DL	0.007	0.007	1.545	0.98	0.005
		Full DL	0.011	0.007	1.545	**1.58**	0.007
Mallard in Slough							
Total DDTs	Amphipod and Fish	1/2 DL	0.014	0.007	1.545	**1.92**	0.01
		Full DL	0.027	0.007	1.545	**3.70**	0.02
Total PCBs and Aroclors	Amphipod and Fish	1/2 DL	0.193	0.097	1.175	**1.99**	0.16
		Full DL	0.384	0.097	1.175	**3.96**	0.33

Notes: All HQs above 1.0 are presented in **bold** text.

* Tissue concentration is estimated based on a literature-derived BAF and maximum sediment concentration.

BAF Bioaccumulation factor
COEC Chemical of ecological concern
DDT Dichlorodiphenyldichloroethane
DL Detection limit
HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
TRV Toxicity reference value

For the Black Rail dose based on a diet of 100 percent amphipods with tissue concentrations estimated using literature BAFs, the $HQ_{(full\ dose/high\ TRV)}$ for total PCBs and Aroclors exceeded 1.0, indicating some unacceptable risk to the typical receptor from PCBs and Aroclors at the site. However the Black Rail dose calculated using 100 percent site-specific clam tissue, all $HQs_{(full\ dose/high\ TRV)}$ were below 1.0. All $HQs_{(full\ dose/low\ TRV)}$ for total PCBs and Aroclors and total DDTs exceeded 1.0, indicating some potential risk to the Black Rail from these chemicals.

For the Mallard, all $HQs_{(full\ dose/high\ TRV)}$ indicated no unacceptable risk from chemical exposure at the site ($HQ_{[full\ dose/high\ TRV]}$ were less than 1.0). However, the $HQ_{(full\ dose/low\ TRV)}$ for total DDTs and total PCBs in the slough slightly exceeded 1.0, indicating a potential for risk to Mallards from these chemicals. For Mallards in the pond, the $HQ_{(full\ dose/low\ TRV)}$ for total DDT exceeded 1.0, indicating a potential for risk from DDT.

A discussion of the risk to the Black Rail and Mallard from total DDTs and total PCBs and Aroclors is provided in the following sections. A risk characterization for the Black Rail and Mallard from total DDTs and total PCBs and Aroclors is provided in Section 7.4.

6.3.1.1 Risk to Black Rail and Mallard from Total PCBs and Total Aroclors

Some unacceptable risk ($HQ_{[full\ dose/high\ TRV]}$ equals 2.38) was indicated for the Black Rail from total PCBs and Aroclors based on a diet of amphipods. However, this dose was based on literature-derived BAFs that have a high degree of uncertainty (Section 7.6). Doses based on site specific clam data were lower than the high TRV.

Some potential risk ($HQ_{[full\ DL\ dose/lowTRV]}$ equals 6.81) was indicated for the Black Rail from total PCBs and Aroclors based on a diet of clams. Potential risk ($HQ_{[full\ DL\ dose/lowTRV]}$ equals 3.96) was also indicated for the Mallard for total PCBs and Aroclors in the slough based on a diet of amphipods and clams.

PCBs bioaccumulate to their highest concentrations in the livers of fish-eating birds followed by species that feed on small birds and mammals, worms, and insects (National Academy of Science [NAS] 1979, as cited in Eisler 1986). In studies of marine food chains, concentrations of PCBs rapidly biomagnify in higher-trophic-level carnivores. Adverse effects associated with exposure to PCBs in aquatic organisms include decreased growth, reproductive toxicity, mutagenicity, histopathology, and a variety of biochemical perturbations (Eisler 1986; Beyer and others 1996).

A risk characterization for the Black Rail and Mallard from total PCBs and Aroclors is provided in Section 7.4.

6.3.1.2 Risk to Black Rail and Mallard from Total DDTs

All $HQs_{(dose/high\ TRV)}$ were less than 1.0, indicating no unacceptable risk to the Mallard or Black Rail. Some potential risk ($HQ_{[full\ dose/low\ TRV]}$ greater than 1.0) was indicated for the Black Rail and Mallard from total DDTs. As in the total PCB and Aroclor doses, most of the modeled total DDT dose to the Black

Rail and the Mallard was from ingestion of amphipod prey, with the conservative assumption of 100 percent bioavailability.

Organochlorine chemicals such as DDT are highly lipophilic and can biomagnify up the food chain. Biomagnification of DDT and trophic-level transfer in both aquatic and terrestrial food chains has been well-documented (Hoffman and others 1995; EPA 1995). DDT is most widely known for its reproductive effects on birds, primarily piscivorous species. DDT and its metabolites can mimic estrogen by binding to specific estrogen receptors inside of cells. Because of this mode of action, the toxicity of DDT primarily affects reproduction. Organochlorines, including DDT, have been implicated in the thinning of eggshells of at least 54 species and 10 orders of birds (Stickle 1975, as cited in Peterle 1991). DDT reduces the transport and transfer of calcium from female into the egg, resulting in thin eggshells.

Mallard hens fed 50 parts per million of DDT produced eggshells weighing 12 percent less than control eggshells and whose thickness was reduced by 18 percent. Birds treated with DDE showed delayed egg laying, reduced nesting success, reduced hatchability, and abnormal egg size and weight (Vangilder and Peterle 1980, 1981, 1983, as cited in Peterle 1991; Grubb and others 1990, Noble and Elliot 1990, King and others 1991, Lincer 1992, Wiemeyer and others 1993, all as cited in DOI 1998). At the Litigation Area, the total daily dose to DDT for the Mallard based on conservative dose parameters (maximum sediment and tissue concentrations) ranged from 7 to 27 parts per million.

A risk characterization for the Black Rail and Mallard from total DDTs is provided in Section 7.4.

6.3.2 Risk to Birds from Inorganic Chemicals

Area doses for inorganic chemicals were calculated for the Black Rail, Suisun Song Sparrow, Mallard, Great Blue Heron, American Kestrel, and Northern Harrier. Calculated doses are discussed by receptor below.

6.3.2.1 Risk to Black Rail

Area doses for seven metals (arsenic, cadmium, copper, lead, mercury, selenium, and zinc) were calculated for the California Black Rail, a special status species, in the slough habitat. Inorganic dose calculations and HQs for the rail are presented in Table 98 and Table G4-5.

Because the Black Rail is a threatened species, maximum doses based on conservative exposure parameters such as maximum tissue and sediment concentrations were calculated, as described in Table 88. All HQs greater than 1.0 are presented below.

Chemical	Diet	Maximum Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (Maximum Dose/Low TRV)	HQ (Maximum Dose/High TRV)
Black Rail						
Arsenic	Amphipods	11.998	2.624	10.503	**4.57**	**1.14**
Cadmium	Amphipods	9.015	0.041	8.432	**218.70**	**1.07**
Copper	Amphipods	52.786	1.239	30.783	**42.60**	**1.72**
Lead	Amphipods	6.434	0.011	4.507	**568.53**	**1.43**
Mercury	Amphipods	0.061	0.019	0.089	**3.19**	0.69
Selenium	Amphipods	0.280	0.111	0.449	**2.52**	0.62
Zinc	Amphipods	1,084.870	8.551	85.508	**126.87**	**12.69**

Notes: All HQs above 1.0 are presented in **bold** text.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value

HQs calculated using the high TRV were slightly greater than 1.0 for arsenic, cadmium, copper, lead, and up to 12.69 for zinc, indicating unacceptable risk to the rail from these chemicals under the maximum dose assumptions. HQs calculated using the low TRV were also greater than 1.0 for mercury and selenium. The risk to the Black Rail from exposure to these chemicals is discussed in Section 6.3.2.6; a risk characterization is presented in Section 7.4.

6.3.2.2 Risks to Suisun Song Sparrow from Inorganic COPECs

Area doses were calculated for inorganic chemicals for the Suisun Song Sparrow. Inorganic dose calculations and HQs for the sparrow are presented in Table 99. Complete results of the dose and HQ calculations are shown in Table G4-6. All HQs greater than 1.0 are presented below.

Chemical	Diet	Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95} Dose/Low TRV)	HQ (UCL_{95} Dose/High TRV)
Suisun Song Sparrow – UCL_{95} Doses						
Arsenic	Plant and amphipod	7.816	2.52	10.07	**3.106**	0.776
	Amphipod	3.907	2.52	10.07	**1.553**	0.388
Cadmium	Plant and amphipod	0.455	0.04	8.08	**11.521**	0.056
	Amphipod	0.308	0.04	8.08	**7.784**	0.038
Copper	Plant and amphipod	23.547	1.19	29.51	**19.819**	0.798
	Amphipod	41.212	1.19	29.51	**34.689**	**1.396**

Chemical	Diet	Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95} Dose/Low TRV)	HQ (UCL_{95} Dose/High TRV)
Suisun Song Sparrow – UCL_{95} Doses (Continued)						
Lead	Plant and amphipod	2.952	0.01	4.32	**272.048**	0.683
	Amphipod	3.416	0.01	4.32	**314.821**	0.791
Mercury	Plant and amphipod	0.022	0.02	0.09	**1.173**	0.254
	Amphipod	0.037	0.02	0.09	**1.987**	0.430
Selenium	Plant and amphipod	1.549	0.11	0.43	**14.552**	**3.599**
	Amphipod	0.157	0.11	0.43	**1.478**	0.366
Zinc	Plant and amphipod	56.195	8.20	81.99	**6.854**	0.685
	Amphipod	91.086	8.20	81.99	**11.110**	**1.111**
Suisun Song Sparrow – Mean Doses						
Copper	Amphipod	34.692	1.19	29.51	NC	**1.260**
Selenium	Plant and Amphipod	1.080	0.11	0.43	NC	**2.510**
Zinc	Amphipod	68.346	8.20	81.99	NC	0.949

Notes: All HQs above 1.0 are presented in **bold** text.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
NC Not calculated
TRV Toxicity reference value
UCL_{95} One-side 95 percent upper confidence limit on the arithmetic mean

HQs calculated using the high TRV were greater than 1.0 for copper, selenium, and zinc, indicating unacceptable risk to the Suisun song sparrow from these chemicals. HQs calculated using the low TRV were greater than 1.0 for all seven metals, indicating potential risk the Suisun Song Sparrow from these chemicals.

As discussed in Section 6.2, a two-step approach to food-chain modeling was used when HQs calculated using the high TRV were greater than 1.0. For these chemicals, a dose using mean EPC was calculated (mean dose) to further refine the risk estimate under a typical exposure scenario. Mean doses calculated for copper and selenium also showed unacceptable risk ($HQ_{mean\ dose/high\ TRV]}$ greater than 1.0) to the Song Sparrow.

Potential risk to the Song Sparrow from arsenic, copper, lead, mercury, selenium, and zinc is further discussed in Section 6.3.2.6; a risk characterization for the Song Sparrow is provided in Section 7.4.

6.3.2.3 Risks to Mallards from Inorganic COPECs

Area doses for seven metals (arsenic, cadmium, copper, lead, mercury, selenium, and zinc) were calculated for the Mallard for the pond and slough habitats. Inorganic dose calculations and HQs that exceed 1.0 for the Mallard are presented in Table 100. Complete results of the dose and HQ calculations are shown in Table G4-7.

All HQs calculated using the high TRV were less than 1.0, indicating no unacceptable risk to the Mallard from inorganic COPECs. HQs greater than 1.0 are presented below.

Chemical	Habitat Area	UCL_{95} Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95} Dose/Low TRV)	HQ (UCL_{95} Dose/High TRV)
Mallard						
Cadmium	Pond	0.162	0.086	17.636	**1.875**	0.009
Cadmium	Slough	0.134	0.086	17.636	**1.555**	0.008
Copper	Slough	11.905	2.592	64.386	**4.593**	0.185
Lead	Pond	0.609	0.024	9.427	**25.711**	0.065
	Slough	0.503	0.024	9.427	**21.231**	0.053
Selenium	Pond	0.677	0.232	0.939	**2.915**	0.721
Zinc	Pond	25.428	17.885	178.852	**1.422**	0.142
	Slough	30.353	17.885	178.852	**1.697**	0.170

Notes: All HQs above 1.0 are presented in **bold** text; arsenic and mercury doses were all below the low TRV and are not listed.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence limit on the arithmetic mean

All HQs calculated with the low TRV for arsenic and mercury were less than 1.0; as a result, these COPECs present little or no risk to aquatic omnivorous birds at the Litigation Area. HQs calculated with the low TRV for cadmium, copper, lead, selenium, and zinc were slightly greater than 1.0, indicating potential risk from exposure to these chemicals. Potential risk to the Mallard from cadmium, copper, lead, selenium, and zinc is further discussed in Section 6.3.2.6. A risk characterization for the Mallard is provided in Section 7.4.

6.3.2.4 Risk to Great Blue Heron from Inorganic COPECs

Area doses were calculated for the Great Blue Heron for the pond and slough habitats. Inorganic dose calculations and HQs for the Great Blue Heron are presented in Table 101. Complete results of the dose and HQ calculations are shown in Table G4-8.

Only lead resulted in HQs greater than 1.0. All HQs calculated using the high TRV were less than 1.0, indicating no unacceptable risk to the Great Blue Heron from inorganic COPECs. HQs for lead greater than 1.0 for which some degree of risk was indicated are presented by habitat area below.

Chemical	Habitat Area	UCL_{95} Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95} Dose/Low TRV)	HQ (UCL_{95} Dose/High TRV)
Great Blue Heron						
Lead	Pond	0.019	0.03	10.89	**5.49**	0.01
	Slough	0.092	0.03	10.89	**3.56**	0.01

Notes: All HQs above 1.0 are presented in **bold** text; arsenic, cadmium, copper, mercury, selenium, and zinc doses were all below the low TRV and are not listed.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence limit on the arithmetic mean

All HQs calculated with the low TRV for arsenic, cadmium, copper, mercury, selenium, and zinc were less than 1.0; as a result, these COPECs present little or no risk to piscivorous birds at the Litigation Area. HQs calculated with the low TRV for lead were slightly greater than 1.0, indicating some potential risk from exposure to lead. Potential risk to the Great Blue Heron from lead is further discussed in Section 6.3.2.6. A risk characterization for the Great Blue Heron is provided in Section 7.4.

6.3.2.5 Risk to American Kestrel and Northern Harrier from Inorganic COPECs

Area doses were calculated for the American Kestrel and Northern Harrier for the marsh surface in RASSs 1 to 3, the upland area of RASS 4, and the Unit 8 remediated area. Inorganic dose calculations and HQs that exceed 1.0 for the American Kestrel and Northern Harrier are presented in Tables 102 and 103. Complete results of the dose and HQ calculations are shown in Tables G4-9 and G4-10.

No HQs calculated using the high TRV were greater than 1.0, indicating no unacceptable risk to the Kestrel or Harrier from inorganic COPECs. HQs calculated using the low TRV greater than 1.0 are presented by habitat area below.

Chemical	Receptor	UCL_{95} Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95} Dose/Low TRV)	HQ (UCL_{95} Dose/High TRV)
RASS 1-3						
Cadmium	American Kestrel	0.21	0.055	11.182	**3.769**	0.018
	Northern Harrier	0.14	0.071	14.532	**1.913**	0.009
Copper	American Kestrel	3.61	1.643	40.826	**2.195**	0.088
	Northern Harrier	2.38	2.136	53.053	**1.114**	0.045
Lead	American Kestrel	0.54	0.015	5.977	**36.143**	0.091
	Northern Harrier	0.36	0.020	7.767	**18.340**	0.046
Selenium	American Kestrel	0.044	0.147	0.595	**2.966**	0.734
	Northern Harrier	0.29	0.191	0.774	**1.505**	0.372
RASS 4						
Lead	American Kestrel	0.08	0.015	5.977	**5.133**	0.013
	Northern Harrier	0.05	0.020	7.767	**2.605**	0.007
Unit 8						
Lead	American Kestrel	0.05	0.015	5.977	**3.117**	0.008
	Northern Harrier	0.03	0.020	7.767	**1.582**	0.004

Notes: All HQs above 1.0 are presented in **bold** text; arsenic and zinc doses were all below the low TRV and are not listed.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence limit on the arithmetic mean

All HQs calculated with the low TRV for arsenic and zinc were less than 1.0; as a result, these COPECs present little or no risk to carnivorous raptors at the Litigation Area. HQs calculated with the low TRV for cadmium, copper, lead, and selenium were greater than 1.0, indicating some potential risk from exposure to these chemicals. A discussion of the risk to the American Kestrel and Northern Harrier from cadmium, copper, lead, and selenium is provided in Section 6.3.2.6. A risk characterization for the American Kestrel and Northern Harrier is provided in Section 7.4.

6.3.2.6 Summary of Risks to Birds from Inorganic Chemicals

The following section discusses the potential risks of inorganic chemicals to birds based on estimated doses. Locations for which unacceptable risk was indicated for birds (dose > high TRV) are discussed in Section 7.0. Risk to birds from inorganic chemicals by habitat area is summarized in the following table.

Chemical	Receptor	Habitat Area	Unacceptable Risk Indicated (Dose Greater than High TRV)
Arsenic	Black Rail[1]	Slough	✓
	Song Sparrow	Slough	*
Cadmium	Black Rail[1]	Slough	✓
	Song Sparrow	Slough	*
	Mallard	Pond and Slough	*
	American Kestrel	RASSs 1 through 3	*
	Northern Harrier	RASSs 1 through 3	*
Copper	Black Rail[1]	Slough	✓
	Song Sparrow	Slough	✓
	Mallard	Slough	*
	American Kestrel	RASSs 1 through 3	*
	Northern Harrier	RASSs 1 through 3	*
Lead	Black Rail[1]	Slough	✓
	Song Sparrow	Slough	*
	Mallard	Pond and Slough	*
	Great Blue Heron	Pond and Slough	*
	American Kestrel	RASSs 1 through 3, RASS 4, and Unit 8	*
	Northern Harrier	RASSs 1 through 3, RASS 4, and Unit 8	*
Mercury	Black Rail[1]	Slough	*
	Song Sparrow	Slough	*
Selenium	Black Rail[1]	Slough	*
	Song Sparrow	Slough	✓
	Mallard	Pond	*
	American Kestrel	RASSs 1 through 3	*
	Northern Harrier	RASSs 1 through 3	*
Zinc	Black Rail[1]	Slough	✓
	Song Sparrow	Slough	✓
	Mallard	Pond and Slough	*

Note: All of receptor chemical pairs listed resulted in doses above the low TRV.

RASS Remedial action subsite

TRV Toxicity reference value

* Dose is between the low and high TRV

1 The Black Rail is a threatened species; therefore, maximum doses were calculated for this receptor.

Arsenic

Some unacceptable risk ($HQ_{[max\ dose/high\ TRV]}$ equals 2.38) was indicated for the California Black Rail and a potential for risk ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 3.11) was indicated to the Suisun Song Sparrow from arsenic in the slough based on the assumptions of the food-chain model. The magnitude of the estimated risk to the rail and sparrow is low (HQs not significantly greater than high TRV). The modeled dose to the Black Rail and Song Sparrow was based on a conservative assumption of 100 percent bioavailability. Most of the modeled dose to the Black Rail and Song Sparrow was from incidental ingestion of sediment. Arsenic does not pose unacceptable risk to the Mallard, Great Blue Heron, American Kestrel, or Northern Harrier.

Cadmium

In the slough, only the dose for the Black Rail slightly exceeded the high TRV ($HQ_{[max\ dose/high\ TRV]}$ equals 1.07).

Some potential risk from cadmium in the slough was indicated to the Song Sparrow ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 11.52) and the Mallard ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.56). Potential risk was indicated to the Mallard ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.88) from cadmium in the pond. In RASSs 1 through 3, potential risk from cadmium was indicated to the American Kestrel ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 3.77) and Northern Harrier ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.91). Cadmium does not pose risk to the Great Blue Heron.

Cadmium levels typically range from 0.05 to 1.0 mg/kg in uncontaminated soils; in rare instances (such as soils derived from the Monterey Shale along the California coast), concentrations reach levels as high as 30 mg/kg (Page and others 1981). At the Litigation Area, the UCL_{95} for cadmium in sediment from the slough, pond, and RASSs 1 through 3 was 19.7, 10.1, and 7.7 mg/kg.

Birds appear to be relatively resistant to the toxic effects of cadmium. Sublethal effects in birds include growth retardation, nephrotoxicity, anemia, damage to the testicles, absorptive epithelium of the duodenum, reduced egg production, and effects on calcium absorption (Scheuhammer 1987).

Most of the modeled dose for the Black Rail was from incidental ingestion of sediment. Because the Black Rail is a threatened species, the dose was based on a 99th percentile sediment concentration (243.8 mg/kg), rather than the UCL_{95} sediment concentration (19.7 mg/kg).

In the RASS 3 pond, potential risk was indicated to the Mallard from cadmium. The majority of the modeled dose to the Mallard was from ingestion of prey, with the conservative assumption of 100 percent bioavailability.

Most of the modeled dose to the harrier and kestrel was from ingestion of prey, with the conservative assumption of 100 percent bioavailability. The UCL_{95} for cadmium in rodent tissue is 1.57 mg/kg.

Cadmium was considered to pose some unacceptable risk to the Black Rail in the slough. Potential risk was indicated to the Suisun Song Sparrow and Mallard in the slough and to the Mallard in the pond. Potential risk from cadmium was also indicated to the Mallard in the RASS 3 pond and the Northern Harrier and American Kestrel in RASSs 1 through 3.

Copper

Some unacceptable risk from copper was indicated for the Black Rail ($HQ_{[max\ dose/high\ TRV]}$ equals 1.7) and Song Sparrow ($HQ_{[UCL95\ dose/high\ TRV]}$ equals 1.4) in the slough; the magnitude of the risk is low based on HQs only slightly greater than 1.0. Some potential risk from copper was indicated for the Mallard in the slough ($HQ_{[UCL95\ dose/high\ TRV]}$ equals 4.6). A potential risk from copper was also indicated to the American Kestrel ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 2.2) and Northern Harrier ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.1) in RASSs 1 through 3. Copper does not pose risk to the Great Blue Heron.

Diets containing elevated copper levels can slow the growth rate, diminish egg production, and cause developmental abnormalities in different avian species (Owen 1981). Most of the modeled dose to the Black Rail, Song Sparrow, Mallard, Northern Harrier, and American Kestrel was from ingestion of prey, with the conservative assumption of 100 percent bioavailability. Risk to avian receptors from copper is further characterized in Section 7.4.

Lead

Some unacceptable risk ($HQ_{[max\ dose/high\ TRV]}$ equals 1.43) was indicated for the Black Rail from lead based on the assumptions of the food-chain model. Potential risk was indicated for both the Suisun Song Sparrow in the slough ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 314.8) and the Mallard in the pond and slough ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 25.7 and 21.2, respectively). Potential risk was also indicated for the Northern Harrier and American Kestrel in RASSs 1 through 3, Unit 4, and Unit 8.

The TRV for lead was based on a study using lead acetate, a highly bioavailable form of lead. Lead in contaminated soil and dust has been estimated at being 10 to 20 percent as bioavailable as lead acetate (O'Flaherty 1998); therefore, model assumptions are conservative, as discussed in Section 7.4.

Absorbed lead produces a variety of effects in avian species, including damage to the nervous system, muscular paralysis, inhibition of heme synthesis, damage to kidneys, damage to the liver, and death (Mudge 1983, as cited in Eisler 1988b). Sublethal lead exposure may also have adverse effects in reproduction in some avian species by decreasing plasma calcium, inhibition of growth, and reduced hatchability of chicks.

Most of the modeled dose from lead to the rail and song sparrow in the slough habitat resulted from incidental sediment ingestion; most of the modeled dose to the mallard in the slough resulted from ingestion of prey. For the RASS 3 pond, the modeled dose to the Mallard was a result of both incidental sediment ingestion and prey ingestion. Most of the modeled dose from lead to raptors was a result of both incidental sediment ingestion and prey ingestion, assuming 100 percent bioavailability. Risk to avian receptors from lead is further characterized in Section 7.4.

Mercury

No mercury dose exceeded the high TRV, so mercury does not pose an unacceptable risk to birds. A potential risk was indicated for the Black Rail ($HQ_{[max\ dose/low\ TRV]}$ equals 3.2) and Suisun Song Sparrow ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.2) from mercury in the slough. No risk from mercury was indicated to the Mallard, Great Blue Heron, Northern Harrier, or American Kestrel (all HQs were less than 1.0).

Sublethal effects of mercury on birds, administered by a variety of routes, include adverse effects on growth, development, immune system, reproduction, blood and tissue chemistry, metabolism, and behavior (Peterle 1991; Spalding and others 1991; Zillioux and others 1993; Spalding and others 1994). These effects manifest themselves as alopecia (abnormal feather loss), increased instances of disease, reduced food intake leading to weight loss, progressive weakness in wings and legs, difficulty flying, reduction in liver size, inability to coordinate muscle movements, and reduced nesting and hatching success (Peterle 1991; Spalding and others 1991; Becker and others 1994; Bowerman and others 1994; Monteiro and Furness 1995; Monteiro and others 1995). Reproductive effects are noted at low doses of mercury long before overt signs of toxicity are apparent in adults (Scheuhammer 1987; Hoffman and Heinz 1998). Significant reproductive effects of chronic dietary inorganic mercury exposure in birds include delayed testicular development, altered mating behavior, reduced fertility, reduced survivability and growth in young, and gonadal atresia.

Most of the modeled dose to the Black Rail and Suisun Song Sparrow was from ingestion of prey, with the conservative assumption of 100 percent bioavailability.

Selenium

Some unacceptable risk was indicated for the Black Rail ($HQ_{[max\ dose/high\ TRV]}$ equals 8.6) and Suisun Song Sparrow ($HQ_{[max\ dose/high\ TRV]}$ equals 3.6) from selenium. Potential risk from selenium was indicated to the Mallard in the RASS 3 pond ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 2.9). Potential risk from selenium was also indicated to the Northern Harrier ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.5) and American Kestrel ($HQ_{[95UCL\ dose/low\ TRV]}$ equals 3.0) in RASSs 1 through 3. Selenium does not pose risk to the Great Blue Heron.

Selenium exposure in the diet or drinking water of avian species is associated with reproductive abnormalities, congenital malformations, selective bioaccumulation, and growth retardation (Eisler 1985b). Selenium has been observed to cause reduced hatching of eggs; decreased egg weight; decreased egg production; anemia; alopecia (abnormal loss of feathers); and embryo deformation, including deformed eyes, beaks, wings, and feet (Ort and Latshaw 1978, Harr 1979, both as cited in Eisler 2000; Heinz 1996b; Skorupa 1996). Alopecia is a "classic" symptom of selenium poisoning (Saiki and Ogle 1995). In general, birds have substantially lower thresholds for reproductive toxicity than placental vertebrates such as mammals (DOI 1998), and eggs are the most reliable tissues for risk- and effect-interpretive purposes in avian species (Ohlendorf and others 1993; Heinz 1996b; Skorupa 1996).

The modeled dose to the Black Rail and Song Sparrow was from ingestion of prey and incidental ingestion of sediment, with the conservative assumption of 100 percent bioavailability.

Zinc

Unacceptable risk was indicated for the Black Rail ($HQ_{[max\ dose/high\ TRV]}$ equals 12.7) and Suisun Song Sparrow ($HQ_{[max\ dose/high\ TRV]}$ equals 1.1) in the slough from zinc based on the assumptions of the food-chain model. Potential risk was indicated to the Mallard in the pond ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 1.7) and the slough ($HQ_{[UCL\ dose/high\ TRV]}$ equals 1.4). Zinc does not pose unacceptable risk to Great Blue Heron, Northern Harrier, or American Kestrel.

Most of the modeled dose to the Black Rail and the Song Sparrow was from ingestion of sediment. The modeled doses for the Suisun Song Sparrow and the Mallard were driven equally by ingestion of prey and sediment. The modeled doses to the Northern Harrier and the American Kestrel were driven by ingestion

of prey. All doses were calculated with the conservative assumption of 100 percent prey and sediment bioavailability.

Different species of birds have varying sensitivities to zinc exposure. Acute effects of zinc in ducks caused mortality and pancreatic degradation (Eisler 1993). Reduced growth and death were observed in poultry chicks fed diets containing elevated zinc levels. Younger stages of life appear to be more sensitive to zinc exposure. The pancreas and bone are primary target organs of zinc in birds (Eisler 1993). Decreased weight gain was observed in Japanese Quail, chickens, and turkeys fed diets containing zinc (NAS 1980).

6.3.3 Risk to Mammals from Organic Chemicals

Area doses for total DDTs and total PCBs and Aroclors were calculated for the salt marsh harvest mouse for Units 1, 2, 4, 6, and 8 and for the river otter in the slough (Table 87). As described in Section 6.2, two doses were calculated for each receptor: one using the DL as a substitute for ND data (full DL dose) and one using one-half the DL as a substitute for ND data (1/2 DL dose) (Table G4-11, Attachment G4). Daily dose estimates for the typical receptor for each chemical were then compared with low and high TRVs to calculate an HQ.

All HQs calculated using the low TRV were less than 1.0, indicating little or no risk for the salt marsh harvest mouse or the river otter from total DDTs, total PCBs, or total Aroclors. Uncertainty associated with the calculated doses is discussed in Section 7.6.

6.3.4 Risk to Mammals from Inorganic Chemicals

Areawide doses for inorganic chemicals were calculated for the salt marsh harvest mouse, gray fox, and river otter. Risk to these receptors from inorganic chemicals is discussed below.

6.3.4.1 Salt Marsh Harvest Mouse

Maximum daily dose estimates for the salt marsh harvest mouse were calculated using data collected in the marsh surface from Units 1, 2, 4, 6, and 8. Maximum concentrations in tissue and 99th percentile concentrations in sediment from the site were used in the doses. Daily dose estimates for each chemical were then compared to low and high TRVs to calculate HQs. Inorganic dose HQs for the salt marsh

harvest mouse are presented in Table 104; these calculations are presented in their entirety in Table G4-13 in Attachment G4. The summary table below shows all HQs that were greater than 1.0, for which some degree of risk was indicated.

Chemical	Habitat Unit	Max Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (Max Dose/ Low TRV)	HQ (Max Dose/ High TRV)
Arsenic	2	0.455	0.393	5.402	**1.16**	0.08
	4	0.684	0.393	5.402	**1.74**	0.13
	6	6.034	0.393	5.402	**15.35**	**1.12**
Cadmium	6	0.091	0.064	2.815	**1.42**	0.03
Copper	6	5.647	2.839	663.720	**1.99**	0.01
Lead	1	0.829	0.002	248.698	**462.75**	0.00
	2	0.588	0.002	248.698	**328.22**	0.00
	4	1.291	0.002	248.698	**720.90**	0.01
	6	2.702	0.002	248.698	**1508.57**	0.01
	8	0.658	0.002	248.698	**367.42**	0.00
Zinc	4	13.212	10.108	486.265	**1.31**	0.03
	6	32.281	10.108	486.265	**3.19**	0.07

Notes: All HQs above 1.0 are presented in **bold** text; selenium and mercury doses were all below the low TRV and are not listed..
HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value

Some unacceptable risk ($HQ_{[max\ dose/high\ TRV]}$ equals 1.12) was indicated to the salt marsh harvest mouse from arsenic in Unit 6; the magnitude of the HQ was low (only slightly above 1.0) HQs calculated using the high TRV were less than 1.0 for all other inorganic chemicals. HQs calculated using the low TRV were greater than 1.0 for arsenic, cadmium, copper, lead, and zinc, indicating potential risk to the salt marsh harvest mouse from these chemicals. No HQs calculated with the low TRV for mercury exceeded 1.0, indicating little or no risk to the mouse from mercury.

Evaluation of $HQ_{(max\ dose/high\ TRV)}$ indicated that risk to the salt marsh harvest mouse was highest in Unit 6; arsenic is the most important risk driver for the salt marsh harvest mouse. For lead, the maximum $HQs_{(max\ dose/low\ TRV)}$ was 1,509. The risk to the salt marsh harvest mouse from exposure to these chemicals is discussed in the following paragraphs.

Arsenic

Arsenic posed unacceptable risk ($HQ_{[max\ dose/high\ TRV]}$ greater than 1.0) to the salt marsh harvest mouse in Unit 6, and a potential risk ($HQ_{[max\ dose/low\ TRV]}$ greater than 1.0) in Units 2 and 4. Arsenic did not pose risk to the mouse in Unit 1 or Unit 8, indicating that chemical concentrations in the marsh reference area and remediated portion of RASS 1 are protective. The $HQ_{(max\ dose/high\ TRV)}$ for arsenic in Unit 6 based on the maximum sediment concentration in that Unit (1,012.8 mg/kg), was 1.12, only slightly greater than 1.0.

Most of the modeled dose to the salt marsh harvest mouse was from sediment ingestion, assuming 100 percent bioavailability. The maximum sediment concentration used in the dose was from sampling conducted in year 1 of postremediation monitoring.

Adverse effects produced by arsenic are highly dose-dependent. At low levels, arsenic may be an essential nutrient and substitute for phosphorous in biochemical reactions (ATSDR 1989). However, at high levels, arsenic is a recognized as an effective poison. Water-soluble arsenic is efficiently absorbed from the gastrointestinal tract and circulated throughout the body. The body burden of arsenic can reach considerable levels, because it can be sequestered in nails, hair, bones, teeth, skin, liver, kidneys, and lungs (ATSDR 1989). In mammalian species, arsenic is a teratogen, which can pass the placental barrier and produce fetal death and malformations consisting of exencephaly, eye defects, and renal and gonadal agenesis (Eisler 1988a; ATSDR 1993a; Domingo 1994). Areas that pose risk to the salt marsh harvest mouse from arsenic are characterized in Section 7.4.

Cadmium

The maximum dose HQ for Unit 6 calculated using the low TRV slightly exceeded 1.0 (1.4), indicating potential risk to the salt marsh harvest mouse from cadmium. Potential risk to the salt marsh harvest mouse from cadmium was not indicated in Units, 1, 2, 4, or 8 (All $HQ_{[max\ dose/low\ TRV]}$ were less than 1.0).

Cadmium has no essential biological function and is highly toxic to plants and most animals. It is a carcinogen and teratogen and a suspected mutagen. Cadmium is associated with severe sublethal effects on reproduction at relatively low environmental concentrations (Eisler 1985a). In mammals, cadmium accumulates in the liver and kidneys and is excreted in the urine at a very slow rate. Chronic toxicity effects of cadmium given orally to rats are decreased motor skills, peripheral neuropathy, weakness, and muscle atrophy. Chronic oral exposure in adult animals produces kidney damage, hypertension, anemia, tumors and, in conjunction with certain dietary deficiencies, osteomalacia. When inhaled, cadmium is a carcinogen that can produce tumors in the lung, trachea, and bronchus.

Metabolic changes, histopathologic alterations, and liver necrosis have been observed in rats, mice, and rabbits after oral exposure to cadmium concentrations ranging from 0.05 to 138 mg/kg-day (ATSDR 1993b). The maximum daily cadmium dose to the salt marsh harvest mouse at the Litigation Area (from Unit 6) is 0.09 mg/kg-day.

Most of the modeled dose to the salt marsh harvest mouse was from incidental soil ingestion, assuming 100 percent bioavailability. Potential risk to the salt marsh harvest mouse from cadmium is further characterized in Section 7.4.

Copper

Copper was considered to pose a potential risk to the salt marsh harvest mouse because the maximum dose HQ calculated with the low TRV exceeded 1.0 (1.99). Potential risk to the salt marsh harvest mouse from copper was not indicated in Units, 1, 2, 4, or 8 (all $HQ_{[max\ dose/low\ TRV]}$ were less than 1.0). The modeled dose to the salt marsh harvest mouse was equally from prey and sediment ingestion.

The toxic effects of copper have been studied on many animals, including cats, dogs, cattle, sheep, rats, mice, horses, guinea pigs, pigs, and monkeys. Different species of animals display varying levels of sensitivity to copper. However, the principle organ affected by exposure to copper is the liver, where copper primarily accumulates in subcellular organelles, causing liver cirrhosis. In addition to liver cirrhosis, copper exposure can cause necrotic kidney tubules and brain damage (Owen 1981). The acute toxic effects of copper given orally produce gastrointestinal irritation, vomiting (including blood), low blood pressure, jaundice from liver necrosis, and coma. Chronic exposure to copper can cause accumulation of copper in the body, leading to lesions in the liver, brain, and eye, plus hemolytic anemia. Potential risk to the salt marsh harvest mouse from copper is further characterized in Section 7.4.

Lead

Lead was considered to pose a potential risk ($HQ_{[max\ dose/low\ TRV]}$ greater than 1.0) to the salt marsh harvest mouse in all units. Most of the modeled dose to the salt marsh harvest mouse was from incidental ingestion of sediment; lead residue in pickleweed was relatively low (maximum concentration 1.7 mg/kg dry weight). The low TRV is based on ingestion of lead arsenate, a bioavailable form, and the estimated site dose is very conservative in its assumption of 100 percent bioavailability.

Lead can have multiple effects in mammalian species. Lead may cause damage to the nervous system, hematological effects, kidney dysfunction, sterility, abortion, neonatal mortality, growth retardation, delays in maturation, and reduced body weight (Amdur and others 1991; Eisler 1988b). Younger

mammals may have greater sensitivity to lead toxicity because of their developing blood brain barrier. Developing capillaries in the brain allow lead levels in the blood to be transported to newly formed components of the brain (Amdur and others 1991). Potential risk to the salt marsh harvest mouse from lead is further characterized in Section 7.4.

Zinc

The maximum dose HQ for Units 4 and 6 calculated using the low TRV slightly exceeded 1.0 (1.3 and 3.2, respectively), indicating some potential risk to the salt marsh harvest mouse from zinc. The modeled dose to the salt marsh harvest mouse from zinc was mainly from incidental sediment ingestion.

Excessive zinc intake adversely affects survival of all mammals tested and causes a wide variety of neurological, hematological, immunological, hepatic, renal, cardiovascular, developmental, and genotoxic effects (Public Health Service 1989, as cited in Eisler 1993). The adverse effects include growth retardation, testicular atrophy, skin changes, and poor appetite (Prasad 1979, as cited in Eisler 1993; Prasad 1995). The pancreas and bone are primary areas of zinc deposition in mammals (Eisler 1993). Toxic effects of zinc can be observed in many domestic animals, including dogs, cats, ferrets, cattle, sheep, and horses, following ingestion of zinc-containing objects (Eisler 1993). Elevated zinc concentrations in the diet of pregnant rats and sheep caused an increased incidence of hypocuprosis, still births, and fetal resorptions (Ketchenson and others 1969, Campbell and Mill 1979, both as cited in Domingo 1994).

Acute oral toxicity in rodents exposed to zinc is low, with lethal dose 50 percent values ranging from 30 to 600 mg/kg body weight, depending on the zinc salt administered (International Programme on Chemical Safety [IPCS] 1996). Acute effects in rodents following inhalation or intratracheal instillation of zinc compounds include respiratory distress, pulmonary oedema, and infiltration of the lung by leucocytes. Effects of zinc toxicity following short-term oral exposure to rodents include weakness, anorexia, anemia, diminished growth, loss of hair, and lowered food utilization. The level at which zinc produced no adverse symptoms in rodents was set at about 160 mg/kg body weight in rats (IPCS 1996).

Long-term oral exposure to zinc indicated the target organs of toxicity to be the hematopoietic system in rats, ferrets, and rabbits; the kidney in rats and ferrets; and the pancreas in mice and ferrets. The no-observed-effects level was reported to be less than 100 mg/kg for zinc sulfate fed to rats with respect to growth and anemia. Increases in zinc concentrations in the body of experimental animals exposed to zinc are accompanied by reduced levels of copper, suggesting that some of the signs of toxicity ascribed to exposure to high levels of zinc may be caused by zinc-induced copper deficiency. Further studies have

shown that exposure to zinc alters the levels of other essential metals in the body of exposed animals, including iron. Some signs of toxicity observed in animals exposed to high levels of zinc can be alleviated by the addition of copper or iron (IPCS 1996). Potential risk to the salt marsh harvest mouse from zinc is further characterized in Section 7.3.

6.3.4.2 Gray Fox

Typical daily dose estimates for the gray fox were calculated using data collected in the marsh surface from RASSs 1 through 3, RASS 4, and Unit 8. UCL_{95} tissue and sediment data from the site were used in the doses. Inorganic dose calculations and HQs for the gray fox are presented in Table 105. Complete results of the dose and HQ calculations are shown in Table G4-14. The summary table below shows all HQs that were greater than 1.0, for which some degree of risk was indicated. All HQs calculated with the high TRV were less than 1.0, indicating no unacceptable risk to the gray fox from inorganic inorganic chemicals.

Chemical	Habitat Unit	UCL_{95} Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95} dose/ Low TRV)	HQ (UCL_{95} Dose/ High TRV)
Lead	RASSs 1 through 3	0.070	0.0013	174.7223	**50.60**	<0.001
	RASS 4	0.176	0.0013	174.7223	**126.95**	<0.001
	Unit 8	0.052	0.0013	174.7223	**37.23**	<0.001
Selenium	RASS 4	0.095	0.0417	0.8931	**2.07**	0.10
	Unit 8	0.081	0.0417	0.8931	**1.76**	0.08

Notes: All HQs above 1.0 are presented in **bold** text; arsenic, cadmium, copper, and zinc doses were all below the low TRV and are not listed.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence limit on the arithmetic mean

Lead poses a potential risk to the gray fox ($HQ_{[UCL95\ dose/low\ TRV]}$ is greater than 1.0) in RASSs 1 through 3, RASS 4, and Unit 8. Selenium poses a potential risk to the gray fox ($HQ_{[UCL95\ dose/low\ TRV]}$ is greater than 1.0) in RASS 4 and Unit 8. Potential risk to the gray fox from lead and selenium is discussed below.

Lead

Lead posed a potential risk ($HQs_{[UCL95\ dose/low\ TRV]}$ greater than 1.0) to the gray fox in RASSs 1 through 3, RASS 4, and Unit 8. As discussed above, lead can have multiple effects in mammalian species, including damage to the nervous system, hematological effects, kidney dysfunction, sterility, abortion, neonatal

mortality, growth retardation, delays in maturation, and reduced body weight (Amdur and others 1991; Eisler 1988b). Potential risk to the gray fox from lead is further characterized in Section 7.4.

Selenium

Selenium posed a potential risk ($HQs_{[UCL95\ dose/low\ TRV]}$ greater than 1.0) to the gray fox in RASS 4 and Unit 8. The $HQ_{[UCL95\ dose/low\ TRV]}$ for selenium was 2.1 in RASS 4 and 1.8 in Unit 8. The majority of the modeled dose from selenium was from selenium concentrations in rodent tissue based on an assumption of 100 percent bioavailability.

Chronic effects of selenium on mammals include reproductive abnormalities such as congenital malformations; reduced numbers of young in litters; high mortality of young; infertility among surviving young in rats, mice, swine, and cattle; and intestinal lesions (Harr 1978, National Research Council 1983, both as cited in Eisler 1985b).

Chronic exposure of selenium, known as "alkali disease," has been observed in cattle, hogs, and horses, which graze on feed containing elevated levels of selenium. Adverse effects include deformed hooves, hair loss, lassitude, articular cartilage erosion, reduced conception, increased reabsorption of fetuses, and heart, kidney, and liver degeneration (Eisler 1985b). Potential risk to the gray fox from selenium is further characterized in Section 7.4.

6.3.4.3 River Otter

Typical daily dose estimates for the river otter were calculated using data collected in the slough. UCL_{95} tissue and sediment data from the site were used in the doses. Two diet scenarios were modeled for the river otter based on a diet of 100 percent clams and 100 percent fish. Inorganic dose calculations and HQs for the river otter are presented in Table 106. Complete results of the dose and HQ calculations are shown in Table G4-15. The summary table below shows all HQs that were greater than 1.0, for which some degree of risk was indicated.

Chemical	Diet	UCL_{95} Dose (mg/kg-day)	Low TRV (mg/kg-day)	High TRV (mg/kg-day)	HQ (UCL_{95}Dose/ Low TRV)	HQ (UCL_{95} Dose/ High TRV)
Lead	Clam	0.07	0.001	172.08	**56.36**	4.06×10^{-4}
	Fish	0.01	0.001	172.08	**5.65**	4.06×10^{-5}
Selenium	Clam	0.05	0.04	0.88	**1.19**	0.06

Notes: All HQs above 1.0 are presented in **bold** text.

HQ Hazard quotient
mg/kg-day Milligram per kilogram per day
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence limit on the arithmetic mean

No unacceptable risk was indicated to the river otter (all $HQ_{[UCL95\ dose/high\ TRV]}$ were less than 1.0) from all inorganic chemicals. The only potential risk to the river otter from inorganic chemicals was for lead and selenium ($HQ_{[UCL95\ dose/low\ TRV]}$ equals 56.36 and 1.19, respectively) based on a diet of clams. However, no risk to the river otter was indicated from selenium ($HQ_{[UCL95\ dose/low\ TRV]}$ less than 1.0) based on a diet of fish. Potential risk to the river otter from lead is further characterized in Section 7.4.

7.0 RISK CHARACTERIZATION

Risk characterization estimates the nature and severity of risks attributable to exposure to stressors at a site and discusses the ecological significance of predicted effects. Risk characterization integrates information from the exposure and effects assessments to evaluate relationships between chemical exposure and the expression of ecological effects. This integration relies primarily on WOE arguments that evaluate all lines of evidence introduced into the risk assessment (Section 7.1). Discussion of uncertainties at each level of the risk assessment is another key component of risk characterization.

The objectives of this section are to:

1. Characterize risk to assessment endpoints at individual locations or within spatial units and habitats at the Litigation Area

2. Characterize the spatial distribution of risk based on individual lines of evidence and identify areas of the site that pose unacceptable population-level risk to assessment endpoints

3. Determine if prior remediation has been effective and if remediated portions of the site remain protective of ecological receptors

The two components of risk characterization are risk estimation and risk description. Risk estimation integrates exposure profiles for each receptor group with information on effects and provides a summary

of the associated uncertainties. Risk description presents the information necessary for interpreting risk results and identifies appropriate thresholds for defining adverse effects for each assessment endpoint. Risk estimation and risk description are discussed separately for plants, fish and aquatic invertebrates, and birds and mammals in Sections 7.2, 7.3, and 7.4. Section 7.5 discusses ecological risk in the active remediation area. Discussion of the uncertainties associated with the risk assessments for individual receptor groups is included in each section. Additional discussion of uncertainties associated with different lines of evidence used in the risk assessment is presented in Section 7.6. The spatial distribution of risk has also been summarized in a series of "risk footprints" that map the spatial extent of key risk indicators for each receptor group. Risk footprints for plants, fish and aquatic invertebrates, and birds and mammals are presented on Figures 77, 93, and 94.

7.1 WEIGHT-OF-EVIDENCE APPROACH

The WOE process provides a way to efficiently organize multiple, and sometimes conflicting, lines of evidence in a manner that supports decision-making (Menzie and others 1996). The WOE approach for the BERA used numeric decision criteria and best professional judgment to interpret results for each of the lines of evidence.

During problem formulation, the Navy and regulatory and trustee agencies discussed decision points or thresholds for individual lines of evidence for each receptor group and the development of an overall WOE approach for integrating the results of the assessment in a manner that would support decision-making. A number of approaches were evaluated, including several complicated methods that used a combination of qualitative and quantitative scores to assign ranks to lines of evidence. Consensus was not reached on any of the proposed approaches. The Navy and the regulatory agencies did agree on a set of decision criteria to be used to evaluate the significance of each line of evidence based on the magnitude of the observed response (Table 54). It was agreed that best professional judgment would be the primary means of integrating results for all lines of evidence and for evaluating the overall significance of the risk findings for each group of receptors.

Summary WOE tables were prepared to characterize risk to upland and wetland plants, fish and aquatic invertebrates, and birds and mammals and are discussed in Sections 7.2, 7.3, and 7.4. The WOE tables provide summaries of results and conclusions for individual lines of evidence as well as overall conclusions about risk characterization for each receptor group based on professional judgment of the significance of the combined results for all lines of evidence. In the WOE process, results for each line of evidence were first used to characterize risk at individual locations across the site. Unacceptable risk at

the population level was generally assessed by (1) the frequency and magnitude of concentrations exceeding threshold criteria for lines of evidences at individual locations; (2) the proportion of locations within individual spatial units or habitats where risk thresholds were exceeded for one or more lines of evidence; and (3) a consideration of other factors, such as the relative strength of individual lines of evidence for indicating unacceptable risk, that affect the interpretation of the combined results for all lines of evidence.

7.2 RISK CHARACTERIZATION FOR PLANTS

Results of the exposure and effects assessment presented in Section 4.0 do not indicate unacceptable risk to populations of upland and wetland plants from metals in sediment and soil at the Litigation Area. A WOE summary for characterizing risk to plants from inorganic COPECs in Litigation Area sediment and soil is provided in Table 107.

Four lines of evidence were used to evaluate risk to populations of upland and wetland plants across the Litigation Area:

1. Results of plant surveys conducted during the 5 years of postremediation monitoring
2. Calculation of BAFs for collocated soil or sediment and plant tissues samples
3. Comparison of tissue concentrations of metals with effects levels from the literature
4. Comparison of soil concentrations of metals with ORNL benchmarks

Conclusions about population-level effects to plants were based on:

1. The extent to which different plant species were collocated with areas of the site where elevated concentrations of metals are common in soil and sediment.
2. The proportion of locations within a habitat where the potential for bioaccumulation of toxicologically significant concentrations of metals poses unacceptable risk.
3. The proportion of locations within a habitat that show unacceptable risk based on comparison of exposure point concentrations of metals in soil or sediment and tissue with probable effects levels (ORNL benchmarks and literature studies).

The tidal wetland in RASS 1 has high habitat value that is reflected by the high diversity of plant species that have been recorded during 5 years of ecological monitoring, the presence of four special status plant species, and the presence of special status animal species like the salt marsh harvest mouse that depend on the pickleweed-dominated plant associations. Common pickleweed, which was selected as a

representative species for wetland plants, is found in all areas of the wetland that provide suitable habitat, including areas in the southeastern portion of RASS 1 where high concentrations of arsenic and zinc are common in soil and sediment. Moreover, soil:pickleweed BAFs indicate that toxicologically significant levels of COPECs are not being accumulated in this species (all BAFs less than 1.0) (Table 70). Several areas in the southeastern portion of RASS 1 (Unit 6) and in RASS 2 (Unit 12) have high levels of metals that exceed ORNL benchmarks and effects levels reported in the literature (Figure 77 and Table 69). Selected locations in Unit 6 and Unit 12 may pose some unacceptable risk to individual plants; however, population-level effects are not considered likely for any wetland species. The greatest threat at a community level to plant assemblages and common pickleweed in the wetland area is presented by the spread of invasive species such as perennial peppergrass and common reed.

Two of the four special status plant species at the Litigation Area, Mason's lilaeopsis and the delta tule pea, are only found along the northern margin of the marsh surface in RASS 1 where concentrations of metals are low and do not pose an unacceptable risk to wetland plants (Figure 77). Soft bird's-beak is found in the northwestern region of RASS 1 at a few locations along the main reach of Lost Slough, and has actively recolonized the remediated portion of RASS 1 in Unit 8. Soft bird's-beak has generally shown an increase in population size during the 5 years or postremediation monitoring and, because most stands are in areas with relatively low concentrations of metals in soil, unacceptable risk is not indicated for this species. Suisun marsh aster has spread along Lost Slough (Unit 11) and the ditches (Unit 7) in areas where arsenic and zinc concentrations are elevated. Stands of Suisun marsh aster also occur in other areas across the marsh surface in RASS 1 where concentrations of metals are below a level of concern. Based on the expansion of marsh aster into areas of the site with high metal concentrations and the existence of stands in areas with relatively low concentrations of metals, unacceptable risk is not indicated for this species.

During a site inspection in July 2001, the Navy and the regulatory agencies observed an area of distressed vegetation in RASS 1 along the berm separating the Litigation Area from GCC and Honeywell, Inc. property (Appendix B). The possible causal factors and risk implications for vegetation on the marsh surface were not assessed as part of this BERA. However, the Navy will address this concern in a future investigation. At a risk management meeting in March 2002, the Navy proposed conducting additional soil and groundwater sampling to address chemical migration issues in this area. Details of this proposal are presented in Section 10.0 in the five-year review report.

Upland plant communities at the Litigation Area are typical of disturbed areas dominated by nonnative grasses. At some locations, individual plants may be affected by concentrations of contaminants that

exceed ORNL benchmarks; however, no special status plant species are found in the upland areas, and habitat quality is low.

7.3 RISK CHARACTERIZATION FOR FISH AND AQUATIC INVERTEBRATES

Details of the exposure and effects assessment for fish and aquatic invertebrates were presented in Section 5.0. This section summarizes conclusions from the exposure and effects assessment and characterizes the risk to fish and aquatic invertebrates from organic (Section 7.3.1) and inorganic (Section 7.3.2) COPECs.

7.3.1 Risk to Fish and Aquatic Invertebrates from Organic Chemicals of Potential Ecological Concern

Results of the exposure and effects assessment presented in Section 5.2.1 do not indicate population-level effects to fish and aquatic invertebrates from total DDTs and total PCBs and Aroclors in sediment at the Litigation Area. A WOE summary characterizing risk from DDTs and PCBs to fish and aquatic invertebrates is provided in Table 108 and is discussed below.

Lines of evidence used to assess risk from exposure to organic COPECs at individual locations at the Litigation Area included:

1. Measured or estimated concentrations of total DDTs and PCBs and Aroclors in sediment and soil (Tables 58 through 62)
2. Estimates of bioaccumulation potential for total DDTs and PCBs based on sediment:tissue BAFs calculated for selected vertebrate and invertebrate species
3. Comparison of sediment concentrations of total DDTs and PCBs and Aroclors with toxicity benchmarks (Figures 79 and 80)

Conclusions that organic COPECs in sediment and soil do not pose unacceptable risk to populations of fish and aquatic invertebrates were based on the low frequencies with which DDTs and PCBs and Aroclors have been detected across the site as well as the generally low concentrations that have been measured or estimated for these chemicals.

The risk assessment for organic COPECs was based on a reevaluation of data collected in the QEA (PRC 1997b) and, per agreement with the regulatory agencies, it considered only exposure to total DDTs and total PCBs and Aroclors in soil and sediment. As discussed in Section 5.2.1, a main focus of this assessment was comparing the relative risk posed by organic COPECs (DDTs and PCBs) and inorganic COPECs at the same locations. Comparison of the relative risk posed by organic versus inorganic

COPECs supports the conclusion that organic COPECs are below a level of concern at the Litigation Area (Figure 81).

The low detection frequencies and high DLs reported for DDTs and PCBs in the QEA introduced considerable uncertainty into the risk assessment for these chemicals. The Navy's reevaluation addressed the uncertainty of estimating total concentrations of DDTs and PCBs based on a high frequency of ND data. Maximum possible or worst-case concentrations of DDTs and PCBs were also used in this analysis to ensure that risk was not underestimated. A few locations with the highest worst-case concentrations of DDTs and PCBs, but with relatively low risk from metals, were identified (Figure 81). The objective of this analysis was to identify portions of the site that would not be considered for future remedial action based on risk from metals but where concentrations of DDTs or PCBs could potentially be above a threshold level of concern. One location in the ditches in Unit 3, two locations in Lost Slough in Unit 9, and one location on the marsh surface in Unit 4 met this criterion. However, none of these locations had detected concentrations of DDT isomers or PCB mixtures.

The exposure and effects assessment for DDTs concluded that concentrations of DDTs are widespread in soil and sediment in the Litigation Area. However, concentrations reflect low-level residual contamination from DDTs legally applied at the site from the mid-1940s until 1972. PCBs were also detected in low concentrations in soil and sediment across the Litigation Area; however, unlike DDTs, no known sources of PCBs exist at the site. The suspected source of PCB contamination is the standard operation of railroad engines along the railroad tracks that cross the site. As discussed in Section 3.2.2, the Navy and the regulatory agencies identified several outstanding concerns during meetings discussing the reevaluation results of organic chemicals. At a meeting in March 2002, the Navy presented a proposal addressing these concerns to the regulatory agencies. In addition, the Navy proposed conducting a focused investigation to collect additional soil samples for the analysis of PCB mixtures (Aroclors) from areas adjacent to the railroad tracks along the northern margin of RASS 3 and from several locations along Nichols Creek downstream from the CPC. Details of this proposal are presented in Section 10.0 in the five-year review report.

7.3.2 Risk to Fish and Aquatic Invertebrates from Inorganic Chemicals of Potential Ecological Concern

Results of the exposure and effects assessment presented in Section 5.2.2 suggest that elevated concentrations of metals in sediment and surface water may pose some unacceptable risk to fish and aquatic invertebrates at selected locations in the main reach (Unit 10) and western arm (Unit 11) of Lost

Slough. A WOE summary characterizing risk from metals to fish and aquatic invertebrates is provided in Table 109 and is discussed below.

Lines of evidence used to assess risk from exposure to inorganic COPECs in sediment and surface water at individual locations at the Litigation Area included:

1. Results of a sediment-water interface bioassay using topsmelt and two bulk sediment bioassays using the amphipods *Eohaustorius estuarius* and *Hyalella azteca*
2. Calculation of BAFs for collocated sediment:tissue samples
3. Comparison of bulk chemistry results with sediment (ER-L, ER-M, and ER-M_q) and surface water (AWQC) toxicity benchmarks

SEM-AVS differences were also calculated at selected locations to estimate the available fraction of metals in sediment. The fraction of metals measured in sediment pore water and recovered in sediment extracts (WET-DI) was also used to estimate the potential for leaching of metals and as an additional estimate of bioavailability.

Population-level effects to fish and aquatic invertebrates were assessed based on:

1. The frequency and magnitude of concentrations exceeding threshold criteria established for individual lines of evidence.
2. The proportion of locations within each spatial unit or habitat where threshold criteria were exceeded for individual lines of evidence.

The exposure assessment for metals concluded that the six metals that have been the focus of postremediation monitoring efforts at the site are the principal risk drivers at the Litigation Area. A screen for 20 metals in sediment and surface water samples from Lost Slough and the ditches in RASS 1 in October 2000 was conducted to determine whether additional metals should be evaluated in the BERA as COPECs. No additional metals were added to the list of COPECs evaluated in the BERA based on the screen of the October 2000 sediment or surface water data. Mercury was added as a COPEC based on estimates of potential bioaccumulation from sediment:tissue BAFs calculated for clams (Section 7.3.2.2). During a site inspection after the BERA was completed, the Navy observed a potential source of aluminum contamination from leaking railcars on the ATSF Railroad property (Section 3.1.2.2). As a result, aluminum was not included as a COPEC in the BERA, and based on an analysis of existing data the Navy does not believe that aluminum is currently a risk driver for ecological receptors in this area. However, the Navy is concerned about potential ongoing releases to the Litigation Area and will contact the railroad and chemical companies to inform them of these concerns.

A risk footprint for fish and aquatic invertebrates was drawn based on results of the exposure and effects assessment presented in Section 5.0 (Figure 93). The spatial distribution of risk across the site was derived from each of the primary lines of evidence for sediment. Significant effects in bioassays provide the strongest evidence that chemicals are bioavailable and are the only line of evidence where toxicity was measured directly. The calculation of BAFs is useful for demonstrating exposure and for estimating bioaccumulation potential; however, results do not indicate the likelihood of harmful effects. Bulk chemistry results provide a rapid and relatively economical means to describe the nature and extent of contamination, but they are often poorly correlated with effects. The mean ER-M_q calculated for the six metals and mercury in soil and sediment was used as a measure of risk based on bulk sediment chemistry that accounts for the additive effects of exposure to mixtures of metals. Elevated mean ER-M_qs in sediment reflect the potential for unacceptable risk to fish and aquatic invertebrates.

Surface waters at the Litigation Area, especially those under tidal influence, show high spatial and temporal variability in total and dissolved metal concentrations. While measurement of metals in surface water is necessary to determine compliance with applicable water quality criteria, surface water data at the Litigation Area have not generally proven useful for identifying specific sources in soil or sediment. Potential risk posed by surface water concentrations of metals is summarized on Figures 38 through 43 and Figures 86 and 87 and in Attachment G3. Because any future remediation at the Litigation Area would be focused on the removal of contaminated soil or sediment, surface water data did not influence the risk footprint (Figure 93). Surface water chemistry results, however, are considered in the WOE summary provided in Table 109.

Summaries and conclusions based on each line of evidence for risk of sediment and surface water to fish and aquatic invertebrates are provided below.

7.3.2.1 Bulk Sediment Bioassays

Toxicity tests using amphipods showed unacceptable risk to aquatic invertebrates at one out of four locations in Unit 10 and at two out of four locations in Unit 11 in Lost Slough; however, at most of these locations the magnitude of concentrations exceeding the threshold levels of concern defined for each bioassay was low (Tables 80, 81, and 84). Amphipod toxicity test results showed no unacceptable risk to aquatic invertebrates at six locations in the Unit 7 ditches, at three locations in Unit 9 in Lost Slough, at two locations in the RASS 3 pond, at one location in the RASS 4 wetland, and at nine locations on the marsh surface (Units 1, 2, 4, and 6). Results from topsmelt sediment-water interface bioassays showed no

unacceptable risk to fish at any location tested (three locations in Unit 9, four locations in Unit 10, one location in Unit 11 in Lost Slough, and at two locations in the RASS 3 pond) (Table 78).

Results of two out of three bioassays performed at the site suggest that sediment in the Litigation Area has the potential to cause toxicity to aquatic receptors, but that potential effects are limited to isolated areas of the site. The lack of association between bulk sediment concentrations of specific metals and other physical and chemical parameters with the bioassay endpoints precludes identifying specific causal factors for toxicity observed at 4 out of the 38 locations that were evaluated (Figure 93). Bioavailability of metals is the most likely factor explaining the presence or absence of toxicity at each of the sites evaluated. Section 5.3 discussed the probable role of concentrations of sulfide, TOC, and iron and physical and chemical factors such as pH and oxidation-reduction potential in determining bioavailability of metals in sediment.

Biogeochemical cycling diagrams show the predominant compartments and forms for each of the six metals and mercury (Figures 88 through 92). Because of the complex nature of biogeochemical cycles for these metals and factors that control bioavailability, it is unlikely that any single variable or set of variables can predict the conditions under which toxicity might be expected. Therefore, while it is concluded that some sediment at the Litigation Area has the potential to cause toxicity, it is not possible to identify the locations where toxic effects are most likely to occur.

The mobility of sediment in the ditches and slough may be an important factor in increasing potential bioavailability of metals to fish and aquatic invertebrates. Physical perturbation of anoxic sediment and mixing of sediment with surface water moving into and out of the ditches and slough may increase the solubility of metals and increase the exposure potential for aquatic receptors. Mobilization and transport of metals, especially zinc, along Nichols Creeks should also be considered a risk factor for aquatic receptors in the sloughs and ditches of southern RASS 1. Controlling contaminant migration may be one means to achieve significant reduction of risk to fish and aquatic invertebrates.

7.3.2.2 Bioaccumulation Potential

Bioaccumulation data are available for only a few organisms at the Litigation Area; however, limited results for the Asiatic clam, fish, tadpoles, amphipods, crayfish, and damselfly nymphs suggest that some metals are bioavailable and are being taken up by aquatic receptors. Some unacceptable bioaccumulation in clam tissue was reported for arsenic, copper, mercury, and zinc in Unit 9; for mercury in Unit 10; and for copper and selenium in Unit 11 in Lost Slough; however, most BAFs were only slightly greater than 1.0 (Tables 74 and 75). Only mercury in one sample from Unit 10 had a BAF that exceeded the threshold

level of concern by a wide margin (BAF equal to 14.3). Some unacceptable bioaccumulation was found for mercury and selenium in stickleback tissue and for copper in crayfish tissue from the RASS 3 pond. All BAFs were less than 5.0 for both the stickleback and crayfish (Table 76). Because the toxicological significance of measured tissue burdens is unknown for most species, however, these data are most useful for indicating potential exposure to chemicals and for estimating prey concentrations for use in food-chain modeling.

Mercury is not considered a risk driver at the Litigation Area; however, uncertainties introduced into the risk assessment by the high analytical DL for surface water and the potential for bioaccumulation should be considered further as part of the risk management at the site. Total and dissolved concentrations of mercury exceeded chronic surface water benchmarks at all locations sampled in October 2000; however, mercury was not detected at any of these locations, and reported concentrations are based solely on the analytical DL. Three of the four locations sampled in October 2000 for Asiatic clams that reported sediment:tissue BAFs greater than 1.0 were in the slough reference area at the confluence of Lost Slough and Suisun Bay; as a result, uncertainty exists concerning the source of mercury.

7.3.2.3 Bulk Sediment Chemistry

Bulk sediment chemistry results show widespread concentrations exceeding sediment benchmarks based on ER-M and ER-M_q values from most spatial units in all habitats (Figures 22 through 33 and Figures 83 and 84). Sediment concentrations of metals are highest in Units 10 and 11 in Lost Slough and in Units 6 and 7 in the southeastern portion of RASS 1. Sediment concentrations of metals, however, are poorly correlated with measured effects in bioassays, and bulk chemistry alone cannot be used to predict the level of unacceptable risk at site locations. Mobility and transport of contaminated sediment may increase the bioavailability potential of metals and, therefore, should be considered a risk factor in the ditches (Unit 7), Lost Slough (Units 10 and 11), and along Nichols Creek downstream from CPC property (Unit 13).

7.3.2.4 Bioavailability of Metals

Calculation of SEM-AVS differences at a subset of locations sampled in October 2000 suggests that an excess of sulfide exists in most anoxic sediment at the Litigation Area and that a significant portion of sediment metals are probably bound and unavailable for uptake by aquatic organisms. Other factors such as high average concentrations of TOC, high concentrations of iron, and high pH also contribute to low availability of metals at the site, as discussed in Section 5.3. Concentrations of metals in sediment pore water and extracts are generally low, suggesting that only a small fraction of sediment metals is soluble

and potentially available for uptake. Low bioavailability of metals should be considered in risk management decisions.

7.3.2.5 Surface Water Chemistry

Surface water chemistry results show widespread concentrations exceeding AWQC for total concentrations of arsenic, copper, and zinc in the ditches (Units 3, 5, and 7), Lost Slough (Units 9, 10, and 11), and Nichols Creek (copper and zinc only) (Figures 38 through 43); however, concentrations of total metals in surface water above AWQC overestimate the bioavailable fraction of metals.

Except for copper, dissolved concentrations of metals were generally below chronic AWQC (Table 68). Elevated concentrations of dissolved copper were detected above AWQC in the ditches (Unit 7), Lost Slough (Units 9, 10, and 11), and Nichols Creek. Dissolved copper may pose some unacceptable risk to aquatic receptors in these areas. However, detection limits for dissolved copper were almost always greater than AWQC, and many of the reported concentrations that exceeded either acute or chronic AWQC for copper were based on ND samples.

Additional assessment of limited surface water sampling conducted by RWQCB using ultra-clean sampling and low-level analysis during the October 2000 field effort was also conducted. Preliminary evaluation of these data suggests that concentrations of several metals, including copper, at the Litigation Area may be overestimated in the Navy's dataset. Table 110 compares results of analyses conducted by the Navy and the RWQCB at four locations in Lost Slough. At all locations, RWQCB results for dissolved copper are significantly less than those reported by the Navy (RWQCB reported concentrations that ranged from 4 to 68 percent of concentrations reported by the Navy). These results are also consistent with samples collected by the Navy and the RWQCB at the mouth of Lost Slough during several incoming and outgoing tidal cycles (discussed in Appendix E). All analyses for dissolved copper reported by RWQCB were below the chronic AWQC for copper of 3.1 µg/L. High analytical DLs for copper in surface water constitute a source of uncertainty in this BERA.

7.3.3 Summary and Conclusions of Risk Characterization for Fish and Aquatic Invertebrates

Results of the exposure and effects assessment indicate that risk from DDTs and PCBs is below a level of concern; however, some unacceptable risk from exposure to metals exists in the main reach (Unit 10) and the western arm (Unit 11) of Lost Slough. Cooccurrence of low levels of toxicity in amphipod bioassays, unacceptable bioaccumulation potential (primarily mercury), and elevated concentrations of metals in

sediment (primary concern is zinc, cadmium, and arsenic) and surface water (primary concern is copper) at some locations, was the basis for this conclusion. The magnitude of effects observed in toxicity tests conducted using slough sediment was small; however, the spatial extent of chemical concentrations detected exceeding criteria and the multiple lines of evidence suggesting unacceptable risk in Units 10 and 11 indicate the potential for population-level effects to fish and aquatic invertebrates (Figure 93).

While some elevated chemistry was detected in Units 3, 5, 7, and 9, and the RASS 3 pond (Unit 13), unacceptable population-level effects are not indicated in these areas based on the absence of toxicity and unacceptable bioaccumulation potential. Unit 7 (ditches) and the RASS 3 pond may act as on-site sources of contaminants to Lost Slough. Potential erosion along Nichols Creek and transport of contaminated soil and sediment into the RASS 3 pond and Lost Slough is also a concern. The Navy will address this concern in a supplemental feasibility study, as discussed in Section 10.0 of the five-year review report.

7.4 RISK CHARACTERIZATION FOR BIRDS AND MAMMALS

Details of the exposure and effects assessment for birds and mammals are presented in Section 6.0. This section summarizes conclusions from the exposure and effects assessment and characterizes risk to birds and mammals from organic (Sections 7.4.1 and 7.4.2) and inorganic (Sections 7.4.3 and 7.4.4) COPECs.

WOE summaries characterizing risk to birds and mammals from exposure to organic and inorganic COPECs are provided in Tables 111 and 112. Unacceptable risk was defined as cases where a modeled dose exceeded the high TRV; doses between the high and low TRV indicate some potential risk.

In cases where unacceptable risk was shown for birds or mammals based on areawide doses, individual locations or areas that pose risk to birds and mammals were identified by back-calculating protective soil concentrations from the dose equation presented in Section 6.0 (equation 6-1). For modeled doses that were driven by incidental ingestion of sediment, the following equation was used to back-calculate soil concentrations (equation 7-1):

$$Soil = \left\{ [(High\ TRV / SUF) * BW] - (C_{prey} * IR_{prey}) \right\} / IR_{soil} \qquad (7\text{-}1)$$

For modeled doses that were driven by mainly prey ingestion, or equally driven by prey and soil or sediment ingestion, the following equation was used to back-calculate soil concentrations (equation 7-2):

$$Soil = \left[(High\ TRV / SUF) * BW\right] / \left[IR_{sed} + (BAF * IR_{prey})\right] \quad (7\text{-}2)$$

For the California Black Rail and the Suisun Song Sparrow, slough and pond habitat areas were assessed in the food-chain model. Although these species have been observed in the ditches, ditch habitat was not modeled for inorganic chemicals because the prey tissues modeled (clams and amphipods) were not available in the ditches. To account for the fact that the rail and sparrow may be exposed to sediments in the ditches, any location where sediment in the ditch, pond, or slough exceeded the back-calculated value was considered to pose unacceptable risk.

Risk to birds and mammals from organic chemicals is characterized in Sections 7.4.1 and 7.4.2 and risk from inorganic chemicals is characterized in Sections 7.4.3 and 7.4.4. Risk to birds and mammals is summarized in Section 7.4.5.

7.4.1 Risk to Birds from Organic Chemicals

Food-chain analysis and literature reviews were the primary tools used to evaluate the potential effects of organic contaminants on birds. Food-chain analysis was used to evaluate ingested doses for the California Black Rail, Mallard, Great Blue Heron, and Northern Harrier using site-specific and literature-derived prey tissue concentrations (as described in Section 6.0).

7.4.1.1 Total DDTs

No unacceptable risk to avian receptors was shown for total DDTs (all $HQs_{[dose/high\ TRV]}$ were less than 1.0 for all receptors). However, some potential risk to the Black Rail and Mallard (some $HQs_{[dose/low\ TRV]}$ were greater than 1.0) from total DDTs was indicated. Doses for the Black Rail that exceeded the low TRV were based on maximum concentrations of DDTs in clam tissue and DDT concentrations in amphipods derived from a sitewide BAF (maximum sediment concentration × sitewide BAF). The dose for the Mallard that exceeded the low TRV was based on maximum DDT concentrations in tissue and a diet of 75 percent amphipods and 25 percent sculpins. All doses exceeding the low TRV used one-half the DL for ND concentrations.

7.4.1.2 Total PCBs and Total Aroclors

No unacceptable risk to the Mallard, Great Blue Heron, or Northern Harrier was shown for total PCBs or total Aroclors. For the Black Rail, unacceptable risk was shown for PCBs and Aroclors based on a diet of 100 percent amphipods with tissue concentrations estimated using literature-derived BAFs and use of the

full DL for ND data ($HQ_{[full\ dose/high\ TRV]}$ for total PCBs and Aroclors exceeded 1.0). However, unacceptable risk was not shown for the Black Rail for doses calculated using 100 percent site-specific clam tissue (all $HQs_{[full\ dose/high\ TRV]}$ were below 1.0) and the full DL. The use of literature-derived BAFs for doses based on an assumed diet of 100 percent amphipod tissue introduces considerable uncertainty into this risk estimate. Because PCBs or Aroclors were not detected in sediment where the modeled dose showed the highest potential for risk (R01DH086, R01DH073, R01DH027, R01DH117, R01SH038, R01SH043, R01SH218, and R01SH082), this finding of risk based on estimated tissue concentrations for amphipods should be viewed with caution.

For the Mallard, RASS 3 pond doses calculated based mostly on a diet of site-specific tissues showed no unacceptable risk from total PCBs and Aroclors ($HQ_{[dose/high\ TRV]}$ less than 1.0). Some potential risk was indicated in slough doses based on BAF-derived amphipod tissue ($HQ_{[dose/low\ TRV]}$ greater than 1.0). Because a high degree of uncertainty associated with literature-derived BAFs exists, estimated risk to the Mallard from PCBs or Aroclors should be viewed with caution.

7.4.2 Risk to Mammals from Organic Chemicals

Food-chain analysis and literature reviews were the primary tools used to evaluate the potential effects of organic contaminants on mammals. Food-chain analysis was used to evaluate doses ingested by the salt marsh harvest mouse and the river otter using site-specific and literature-derived prey tissue concentrations (as described in Section 6.0). No HQs calculated using the low TRV were greater than 1.0, indicating no unacceptable risk to the salt marsh harvest mouse or the river otter from total DDTs, total PCBs, or total Aroclors.

7.4.3 Risk to Birds from Inorganic Chemicals

Bioaccumulation of contaminants in birds at the site was not measured directly. However, a single Black Rail carcass and a single Sora (*Porzana carolina*) carcass were found at the site in 1996 (PRC 1997b). The tissue of these birds was analyzed; tissue residues from these individuals were compared with literature values of potential effects; only zinc approached levels that might cause adverse effects in these species (PRC 1997b).

Food-chain analysis using site-specific prey tissue concentrations and comparison of ingested doses of contaminants with TRVs was the primary line of evidence for evaluating risk to avian receptors at the site. This evaluation focused on birds, including the Black Rail, Song Sparrow, Mallard, Great Blue

Heron, American Kestrel, and Northern Harrier, representing a variety of feeding guilds. The model and assumptions are discussed in Section 6.0. Risk to the modeled receptors is characterized below.

7.4.3.1 Risk to the Black Rail

Area doses for seven metals (arsenic, cadmium, copper, lead, mercury selenium, and zinc) were calculated for the California Black Rail in the slough habitat. HQs calculated using the high TRV were greater than 1.0 for arsenic, cadmium, copper, lead, and zinc, indicating unacceptable risk to the rail from these chemicals under the maximum dose assumptions. A back-calculation approach was used to identify locations in the slough and ditches that may pose unacceptable risk to the rail. Areas with some unacceptable risk for the Black Rail are shown on Figure 94. Risk to the Black Rail from these chemicals is discussed below.

Arsenic

Most of the modeled dose to the Black Rail was from incidental ingestion of sediment. A back-calculated sediment concentration of 246.8 mg/kg would make the Black Rail $HQ_{(max\ dose/high\ TRV)}$ for arsenic less than or equal to 1.0 (using equation 7-1); slough or ditch locations where sediment concentrations exceed this value are considered to pose unacceptable risk to the Black Rail. Locations where arsenic poses unacceptable risk to the Black Rail are listed below in order from highest to lowest sediment concentration:

Slough	Unit 7 Ditch
R01SH077, R01SH051, R01SH254, R01SH075, R01SH058, R01SH130, R01SH255, R01SH251, R01SH244, R01SH256, R01SH098	R01DH067, R01DH266, R01DH249, R01DH100, R01DH241, R01DH250, R01DH261, R01DH265, R01DH120, R01DH240, R01DH113, R01DH248, R0DH092

Cadmium

Most of the modeled dose to the Black Rail from cadmium was from incidental ingestion of sediment. Because the Black Rail is a threatened species, the dose was based on a maximum sediment concentration (243.8 mg/kg), rather than the UCL_{95} sediment concentration (19.7 mg/kg). A back-calculated sediment concentration of 227.5 mg/kg would make the Black Rail $HQ_{[max\ dose/high\ TRV]}$ for cadmium less than or equal to 1.0 (using equation 7-1). Sampling locations in the sloughs or ditches with sediment cadmium

concentrations above this level are considered to pose unacceptable risk to the Black Rail; these locations only include R01SH244 and R01SH251 in the Unit 11 slough.

Copper

The majority of the dose for copper was from concentrations in prey. A back-calculation (using equation 7-2) was used to derive a sediment concentration that would make the Black Rail $HQ_{[max\ dose/high\ TRV]}$ for copper less than or equal to 1.0. The back-calculated sediment concentration is 95.9 mg/kg; slough or ditch locations where sediment concentrations exceed this value are considered to pose unacceptable risk to the California Black Rail. Locations where copper poses unacceptable risk to the Black Rail are presented below in order from highest to lowest sediment concentration:

Slough	Unit 5 Ditch	Unit 7 Ditch
R01SH251, R01SH058, R01SH074, R01SH131, R01SH132, R01SH244, R01SH097, R01SH235, R01SH105, R01SH081, R01SH098, R01SH245, R01SH077, R01SH051, R01SH239, R01SH134, R01SH236, R01SH075, R01SH254, R01SH111, R01SH050, R01SH015, R01SH247, R01SH243, R01SH130, R01SH112, R01SH256, R01SH133, R01SH229, R01SH234, R01SH082, R01SH118, R01SH252, R01SH25, R01SH206, R01SH224, R01SH046, R01SH231, R01SH055, R01SH029, R01SH223, R01SH221, R01SH228	R01H096, R01DH117, R01DH057, R01SH073	All Locations

Lead

The Black Rail dose for lead was driven mainly by concentrations of lead in sediment. A back-calculated lead sediment concentration (based on equation 7-1) that would make the black rail $HQ_{(max\ dose/high\ TRV)}$ for lead less than or equal to 1.0 is 90.9 mg/kg; slough and ditch locations where sediment concentrations exceed this value are considered to pose unacceptable risk to the California Black Rail. Locations where lead poses unacceptable risk to the Black Rail are presented below in order from highest to lowest sediment concentration:

Slough	Unit 5 Ditch	Unit 7 Ditch
R01SH251, R01SH131, R01SH132, R01SH244, R01SH245, R01SH235, R01SH051, R01SH081, R01SH231, R01SH077, R01SH098, R01SH082, R01SH247, R01SH134, R01SH105, R01SH133, R01SH130	R01DH117, R01H096, R01SH073, R01DH057	R01DH249, R01DH266, R01DH248, R01DH259, R01DH263, R01DH067, R01DH100, R01DH241, R01DH090, R01DH113, R01DH261, R01DH120, R01DH041, R01DH265, R01DH099, R01DH260, R01DH121

Zinc

The highest potential risk from zinc to the Black Rail was in the slough habitat. A back-calculated sediment concentration of 1,459 mg/kg, based on the median amphipod BAF (using equation 7-2), would make the Black Rail $HQ_{[max\ dose/high\ TRV]}$ for zinc less than or equal to 1.0; ditch or slough locations where sediment concentrations exceed this value are considered to pose unacceptable risk to the California Black Rail and are presented below:

Slough	Unit 5 Ditch	Unit 7 Ditch
R01SH251, R01SH244, R0SH254, R01SH097, R01SH081, R01SH098, R01SH082, R01SH111, R01SH245, R01SH247, R01SH075, R01SH077, R01SH131, R01SH074, R01SH112, R01SH132, R01SH134, R01SH252, R01SH130, R01SH243, R01SH239, R01SH256, R01SH105, R01SH236, R01SH050, R01SH133, R01SH235	R01DH096, R01DH117, R01DH057, R01DH124 R01DH049	R01DH265, R01DH266, R01DH090, R01DH241, R01DH120, R01DH100, R01DH121, R01DH113, R01DH067, R01DH099

Mercury and Selenium

Using conservative assumptions in the dose model and comparing high doses with low TRVs, (no-observed-adverse-effects level [NOAEL] equivalents), some potential risk to individuals exposed year-round to maximum site concentrations of mercury and selenium is indicated. Since this scenario is possible, but not likely, unacceptable risk to populations of the Black Rail from these chemicals is not indicated.

7.4.3.2 Risk to the Song Sparrow

Risk to the Song Sparrow was evaluated using two diet scenarios: one based on amphipods and one based on plants and amphipods. HQs calculated using the high TRV were greater than 1.0 for copper and zinc based on an amphipod diet. HQs calculated using the high TRV were greater than 1.0 for selenium based on a plant and amphipod diet. Mean doses calculated for copper and selenium also showed

unacceptable risk ($HQ_{[mean\ dose/high\ TRV]}$ greater than 1.0); however, mean doses calculated for zinc indicated no unacceptable risk. Risk to the Song Sparrow from copper and selenium is discussed below.

HQs calculated using the low TRV (based on a NOAEL) were greater than 1.0 for all seven metals, indicating the potential for some risk to individual Song Sparrows from these chemicals at maximum site concentrations.

Copper

The majority of the Song Sparrow copper dose was from ingestion of prey. A back-calculated sediment concentration based on the median amphipod BAF (using equation 7-2) of 95.7 mg/kg would make the Song Sparrow $HQ_{(max\ dose/high\ TRV)}$ for copper less than or equal to 1.0, which is similar to the back-calculated concentration for the Black Rail (95.9 mg/kg). Areas that pose unacceptable risk to the Song Sparrow from copper are the same locations identified as posing risk to the Black Rail above.

Selenium

The majority of the Song Sparrow selenium dose was from ingestion of bulrush tissue, which was collected in 1991 for the baseline conditions report (PRC 1994). The Song Sparrow dose based on an amphipod diet showed no unacceptable risk (All $HQ_{[max\ dose/high\ TRV]}$ less than 1.0). Amphipod tissues were collected in 1996 from the slough. A higher degree of uncertainty is associated with the 1991 plant tissue data set compared with the amphipod data, and the finding of risk based on the plant diet should be interpreted with caution.

7.4.3.3 Risks to the Mallard, Great Blue Heron, Northern Harrier, and American Kestrel

Areawide doses were calculated for the Northern Harrier and American Kestrel for six metals (arsenic, cadmium, copper, lead, selenium, and zinc); Mallard and Great Blue Heron doses were calculated for seven metals (arsenic, cadmium, copper, lead, mercury, selenium, and zinc). All HQs calculated with the high TRV were less than 1.0, indicating no unacceptable risk to populations of these birds from these chemicals.

For the Mallard, all HQs calculated with the low TRV for arsenic and mercury were less than 1.0; as a result, these COPECs present no risk to aquatic omnivorous birds at the Litigation Area. HQs calculated with the low TRV for cadmium, copper, lead, selenium, and zinc were greater than 1.0, indicating the potential for some risk to individual Mallards from exposure to these chemicals in the pond and slough.

For the Great Blue Heron, HQs calculated with the low TRV for arsenic, cadmium, copper, mercury, selenium, and zinc were less than 1.0; as a result, these COPECs pose no unacceptable risk to piscivorous birds at the Litigation Area. HQs calculated with the low TRV for lead were greater than 1.0, indicating the potential for some risk to from exposure to lead in the pond and slough.

For the Northern Harrier and American Kestrel, all HQs calculated with the low TRV for arsenic and zinc were less than 1.0; as a result, these COPECs present little or no risk to carnivorous raptors at the Litigation Area. HQs calculated with the low TRV for cadmium, copper, lead, and selenium were greater than 1.0, indicating the potential for some risk to from exposure to these chemicals.

7.4.4 Risk to Mammals from Inorganic Chemicals

Bioaccumulation data (limited), food-chain analysis, and literature reviews were used to evaluate the potential effects of inorganic contaminants on mammals. Small mammals at the site did accumulate the six metals of concern analyzed for in kidney, liver, and femur samples (PRC 1997b); these data indicate the potential for uptake and storage of contaminants, but cannot be related directly to effects.

Food-chain analysis was used to evaluate doses ingested by selected receptors using site-specific prey tissue concentrations (as described in Section 6.0). Food-chain analysis using site-specific data provides a relatively good estimate of dose for those receptors and COPECs for which data are available. The risk to the salt marsh harvest mouse, gray fox, and river otter from inorganic chemicals is characterized below.

7.4.4.1 Salt Marsh Harvest Mouse

Unacceptable risk to the salt marsh harvest mouse was shown only for arsenic in Unit 6 ($HQ_{[max\ dose/high\ TRV]}$ equals 1.1). Most of the modeled arsenic dose was from incidental ingestion of sediment. A back-calculated sediment concentration of 905 mg/kg would make the $HQ_{[max\ dose/high\ TRV]}$ for arsenic in Unit 6 less than or equal to 1.0 (using equation 7-1). A sediment concentration of 53.5 mg/kg would make the $HQ_{(max\ dose/low\ TRV)}$ for arsenic in Unit 6 less than 1.0. Sampling locations on the marsh surface with soil concentrations of arsenic above 905 mg/kg are considered to pose unacceptable risk to the salt marsh harvest mouse; these locations include (in order from the highest level of risk to the lowest) R01SS083, R01SS078, R01SS091, R01SS108, R01SS264, and R01SS128 (Figure 94).

Doses compared with low TRVs (analogous to NOAELs) indicate that individuals exposed year-round to maximum site concentrations may be at some risk from cadmium, copper, and zinc in Unit 6 and lead in Units 1, 2, 4, 6, and 8 (HQs calculated using the low TRV were greater than 1.0).

Risk to the salt marsh harvest mouse is also likely overestimated due to the use of soil chemistry data that includes the top 6 inches of wetland soil; the most contaminated layer is down at 3 to 5 inches bgs, below the level of exposure for the mouse.

7.4.4.2 Gray Fox

Comparison of gray fox doses with TRVs does not indicate unacceptable risk (all HQs calculated using the high TRV were less than 1.0) from exposure to metals at the site. Doses compared with low TRVs indicate that exposure to lead (in RASSs 1 through 3, RASS 4, and Unit 8) and selenium (in RASS 4 and Unit 8) may present some risk (HQs calculated using the low TRV were greater than 1.0). Population level effects are not expected.

7.4.4.3 River Otter

No unacceptable risk is indicated for the river otter from exposure to any metals at the site (all HQs calculated using the high TRV were less than 1.0). Comparison of modeled doses with the low TRVs indicates that site concentrations of lead and selenium may present some potential risk to river otters in the slough.

7.4.5 Summary and Conclusions of Risk Characterization for Birds and Mammals

Results of the exposure and effects assessment presented in Section 6.0 and summarized in this section suggest that risk from DDTs, PCBs, and Aroclors is not of concern, but that unacceptable risk from exposure to some metals exists for selected bird and mammal receptors in certain portions of the Litigation Area. This conclusion is supported primarily by comparison of doses estimated using food-chain models with TRVs. Figure 94 shows the areas of potential unacceptable risk to birds and mammals.

The Navy has proposed additional soil sampling for PCBs at locations adjacent to the Southern Pacific Transportation Company Railroad along the northern margin of RASS 3 and at several locations in Nichols Creek downstream of the CPC to address data gaps (Section 3.2.2). Details of this proposal are presented in Section 10.0 in the five-year review report. If the investigation results indicate that PCBs are present in these areas at unacceptable concentrations, the Navy and the regulatory agencies will consider the risk implications to birds and mammals and determine whether any remedial action is needed.

Some unacceptable population-level risk from exposure to metals may exist for the California Black Rail (risk driver is zinc) and Suisun Song Sparrow (risk driver is selenium) along areas of the main reach (Units 9 and 10), the western arm of Lost Slough (Unit 11), and the ditches (Units 5 and 7).

Some unacceptable risk is indicated for individual salt marsh harvest mice from arsenic at a small number of locations in Unit 6; however, unacceptable risk of population-level effects is not indicated for the harvest mouse.

During a meeting in March 2002, the regulatory agencies raised concerns about the area of semilithified soil observed during the July 2001 site inspection in RASS 4. The Navy has proposed additional soil sampling in this area to better characterize this material and determine whether it poses unacceptable risk to human or ecological receptors. Details of this proposal are presented in Section 10.0 in the five-year review report.

7.5 ECOLOGICAL RISK IN ACTIVE REMEDIATION AREAS

Removal of contaminated soil from portions of RASS 1, RASS 2, RASS 3, and RASS 4 was effective in reducing contaminant concentrations. No unacceptable risk to plants, fish and aquatic invertebrates, or birds or mammals was shown for any chemical in the remediated portions of the site. Mobilization and migration of metals in the remediated portion of RASS 3 is of concern because of the potential risk to aquatic receptors downstream.

7.6 UNCERTAINTY ANALYSIS

Uncertainty plays an important role in risk-based decision-making and is therefore incorporated explicitly into the risk characterization. Identifying known sources of uncertainty is more useful than using conservative default assumptions because potential error is made more explicit in the risk management process (Suter 1993). Uncertainty is generally defined as a component of risk or degree of hazard resulting from imperfect knowledge of the present or future state of the system under consideration (Suter 1993).

The following three sources of uncertainty in ERAs are described in Suter (1993):

- Mistakes in execution of assessment activities (errors such as incorrect measurements, data recording errors, and computational errors)
- Imperfect knowledge of factors that could be known (lack of knowledge about some aspect of the ecosystem that may be relevant, such as assumptions used in dose models; practical constraints on the ability to measure everything; and lack of knowledge on the toxicological effects of all chemicals on all species)
- Inherent randomness of the world (stochasticity in physical or biological processes that may affect assumptions or actual risk such as variation in population parameters or rainfall patterns)

The complexity of ecological systems tends to increase the level of uncertainty involved in ERAs compared with human health risk assessments. Using realistic assumptions and multiple lines of evidence is the best approach to reducing the uncertainty associated with conclusions in an ERA. The following sections briefly review some sources of uncertainty identified for the BERA at the Litigation Area.

7.6.1 Sampling and Data Analysis

Data collected using a statistically based sampling design were used to evaluate site conditions for the entire Litigation Area; as a result, measurements obtained from samples must be used to estimate the true population parameters of interest and each of these estimates has associated error (Gilbert 1987).

Arsenic, cadmium, copper, lead, mercury, selenium, and zinc were evaluated as COPECs in the BERA based on conclusions set forth in the QEA and on results of 5 years of postremediation monitoring. The sample sizes from these combined data sets and spatial coverage of the site are considered more than adequate for characterizing the nature and extent of contamination by these chemicals. For evaluations of contaminants in surface water, however, high analytical DLs for some metals introduced uncertainty for comparing estimated concentrations of metals with water quality criteria. This uncertainty is especially evident for copper, where analytical DLs frequently exceeded total and dissolved water quality criteria and a high percentage of samples for copper were below the reported DLs. Therefore, the extent to which copper actually exceeds the water quality criteria is unknown.

The reevaluation of data for total DDTs and PCBs in soil and sediment was largely based on assessing uncertainties associated with low detection frequencies and high DLs. Conservative or worst-case estimates of total concentrations of DDTs and PCBs were used in this case to guard against underestimating risk. Results of this analysis showed that even with the assumption of worst-case concentrations, these chemicals probably pose little risk to ecological receptors at the Litigation Area.

Data used in the BERA were validated and determined to be of high usability. Data quality, as identified and defined in the QAPP (TtEMI 2000d), is not considered an important source of uncertainty in the BERA; most of the uncertainty associated with the chemistry data reflects limitations in analytical methods and instruments, and does not appreciably affect conclusions of the risk assessment.

7.6.2 Screening Values

Screening values (such as the ER-L and ER-M, ORNL benchmarks, and AWQC) used to identify COPECs and determine levels of risk to ecological receptors include multiple sources of uncertainty. Although these values were based on numerous studies, the relevance of any benchmark to the site is

unknown. Effects on receptors at the site may be underestimated or overestimated based on this approach; however, the practice of using these values for screening chemicals in environmental media is widespread and is currently the best method available for preliminary screening. Results of several biological tests were used in the risk characterization, thereby reducing the level of uncertainty associated with screening values. Screening values were not available for all chemicals detected at the Litigation Area; as a result, some COPECs could not be adequately evaluated given current knowledge. Most of the screening values employed are based on single chemical exposures or on single chemicals analyzed within the context of effects observed in complex chemical mixture exposures. The effect of multiple chemical stressors operating synergistically or antagonistically is not incorporated into this level of screening, although the application of bioassays within the ERA provides a well-established approach for evaluating chemical mixtures (Parkhurst and others 1989).

Screening values are based on total concentrations and do not address uncertainty associated with individual chemical species (some forms are more toxic than others) or bioavailability potential. In some cases, screening benchmarks were used where they are not strictly appropriate. For example, the ORNL screening benchmarks for plants were developed for assessing potential risk to terrestrial plants, and they are not considered suitable for evaluating wetland plant species. Similarly, ER-Ls and ER-Ms are sediment benchmarks for assessing risk to some groups of aquatic receptors, yet the ER-L, ER-M, and ER-M_q were used to evaluate risk to all fish and aquatic invertebrates at the Litigation Area. The lack of suitable screening values for certain chemicals and groups of receptors is considered an important source of uncertainty in the BERA.

7.6.3 Bioassays

Bioassays were conducted using one fish and two sediment-dwelling amphipods; results were extrapolated to all fish and aquatic invertebrates at the Litigation Area. Bioassays and test endpoints were selected based on the known sensitivity of the test species to metals. However, aquatic receptors at the Litigation Area probably exhibit a wide range of sensitivity to contaminants in sediment and water, and uncertainty is introduced by extrapolating results from bioassays to the assessment of natural populations. Although bioassays are a standard method of evaluating toxicity to *in situ* populations, exposure conditions in bioassays do not duplicate exposure conditions in the field, adding uncertainty to the risk assessment.

Results of bioassays indicate that aquatic organisms are potentially at risk from exposure to Litigation Area sediment. However, uncertainty exists about the specific factors responsible for the observed

toxicity. At the four locations where significant toxicity occurred, effects were not correlated with bulk concentrations of chemicals. A wide range of chemical, biological, and physical factors control the form of chemicals in the environment, and have the potential to influence the bioavailability of contaminants in sediment and water. For the most part, chemical factors such as pH, redox, and concentrations of TOC and sulfide indicate that a large fraction of metals present in soil and sediment in the Litigation Area is bound and relatively unavailable for uptake by ecological receptors.

7.6.4 Uncertainties Associated with Food-chain Modeling

The following discussion highlights uncertainties associated with the food-chain modeling used to evaluate risk to birds and mammals in Section 6.0.

7.6.4.1 Tissue Residue Data

Collocated soil and sediment and tissue samples from the Litigation Area provide an empirical measure of the transfer of chemicals from environmental media to biological tissue. Clam samples collected at 10 locations, including areas that have historically shown high concentrations of metals, probably provide good estimates of bioaccumulation potential. For other taxa such as fish, tadpoles, crayfish, amphipods few samples were collected. The small sample sizes for some tissue types introduce uncertainty into estimates of bioaccumulation potential for these other taxa. For mobile organisms such as fish, uncertainty exists concerning the locations where exposure occurred. This uncertainty also exists to some extent for clams, since it was necessary to extend collection efforts at several locations beyond the original sampling locations to obtain sufficient numbers of clams for analysis. Another source of uncertainty is introduced by using literature-derived BAFs to estimate tissue concentrations when site-specific data are unavailable or limited.

Uncertainties discussed for animal tissue are generally less problematic than those for plant tissue. For example, plants are immobile, making collection of collocated samples easy. Large sample sizes of pickleweed were obtained, yielding higher confidence in measured concentrations of chemicals. Chemical concentrations in other plant species for which sample sizes were small (such as bulrush) are much less certain.

7.6.4.2 Estimated Doses

Assumptions used in estimating ingested doses are identified in Section 6.0. These assumptions and model parameters are based mostly on scientific literature and may not accurately represent species or

conditions at the site. In addition, doses were estimated using a closed system, which may not be representative of conditions and relationships present in ecological food webs.

Sources of uncertainty in dose estimates include inaccuracy in model parameters based on limited data in the literature, population and individual variation in life history, and variation in foraging patterns of animals at the site. For example, the diet of many receptors varies seasonally, yet tissue concentrations used in the dose estimate represented a single, brief period. The lack of empirical data for each receptor necessitated the use of simple scaling equations to estimate receptor-specific ingestion rates; these estimates may not accurately represent actual ingestion rates and are a source of uncertainty in the dose calculation. In addition, the use of ingestion-base dose models to estimate exposure assumes that exposure via other routes, such as dermal, inhalation, or drinking of surface water, is negligible. In general, it is common practice in ERAs to focus on ingestion of contaminated prey and soil (Pascoe and others 1996; EPA 1997a), although ignoring other sources may underestimate risk.

An additional source of uncertainty is introduced in the estimation of food ingestion rates. Food consumption was estimated from allometric regression models based on metabolic rate derived by Nagy and others (1999) for various groups of birds and mammals. Food ingestion rates estimated using those allometric equations are expressed as kilograms of dry weight per day. Wildlife do not generally consume dry food (unless maintained in the laboratory); as a result, some investigators suggest converting food consumption rates to kilograms of fresh weight by adding the water content of the food (Suter and others 2000). However, because tissue residue results from the analytical laboratories used in the BERA were reported in wet weight, it was necessary to convert the tissue results to dry weight for mathematical consistency in the allometric equations used to estimate doses. Further reasoning behind the conversion from wet to dry weight is that the TRVs were derived from laboratory studies using dry weight. The conversion from wet to dry weight may overestimate chemical concentrations in tissue, potentially resulting in higher calculated risk. In addition, some uncertainty exists regarding potential evaporation of moisture in the laboratory from tissues awaiting analysis. The “true” wet weight of the tissue reported may therefore also result in an overestimation of chemical concentration.

7.6.4.3 Toxicity Reference Values

Uncertainty associated with the derivation and use of TRVs is described in “Development of Toxicity Reference Values as Part of a Regional Approach for Conducting Ecological Risk Assessments at Naval Facilities in California” (EFA West 1998). Allometric conversion was incorporated in the derivation of TRVs for site-specific receptors; use of this type of body scaling to extrapolate between taxa is a source

of uncertainty, as the underlying assumption that a given effect on a small bird is the same as on a larger bird per unit body weight may not be true. This uncertainty was minimized by extrapolating between closely related species, whenever possible.

Uncertainty is also introduced in cases where the specific form of the chemical administered in the laboratory studies that the TRVs are based on is known to be more available than the form or forms that animals are exposed to at the site. This uncertainty has been problematic for chemicals such as lead (administered as lead acetate in drinking water), but is probably true as well for arsenic (sodium arsenite in drinking water), cadmium (soluble cadmium chloride in drinking water), copper (soluble cupric sulfate in drinking water), manganese (as manganese oxide in drinking water), nickel (as nickel chloride in drinking water), selenium (as selenite and selenate in drinking water), and zinc (as zinc carbonate in drinking water) (Schroeder and others 1968; Webster 1988; Pocino and others 1991; Gray and Laskey 1980; Smith and others 1993; Harr and others 1966; Aughey and others 1977).

7.6.4.4 Hazard Quotients

HQs that result from comparing site chemicals with screening values and comparing ingested doses with TRVs are common in ERAs (EPA 1992b, 1997a; Tiebout and Brugger 1995). An HQ greater than 1.0 is generally considered to indicate a potential for risk; however, the HQ cannot be used to gauge either the probability or the magnitude of effects. The HQ approach has been criticized (Tiebout and Brugger 1995), and caution should be exercised in the interpretation of HQs.

7.6.4.5 Interspecies Extrapolation

The use of allometric conversions in interspecies extrapolations has been discussed elsewhere in Section 7.5. The use of assessment endpoint species as surrogates for other related or ecologically similar taxa is supported by current guidance (EPA 1992a, 1992b, 1997a, 1999). However, it should be recognized that differences among taxa are not accounted for in this type of analysis and that uncertainty exists with regard to assessments of risk to whole communities based on detailed analysis of only a few species.

7.6.4.6 Individual and Population Variation

Individuals within a population vary in several life history and behavioral traits. The dose models incorporated some of this variability by estimating typical values for most model parameters. However, the majority of these models focuses on adult individuals and may not accurately represent ingestion of

chemicals by juvenile stages that may feed in a different manner or on different prey. Even among adults of the same population, there may be considerable individual variation in exposure.

7.6.4.7 Potential Confounding Factors

Nonchemical stressors may confound the interpretation of the effects of chemical stressors that are the focus of the BERA. Nonchemical stressors in soils include factors such as salinity, pH, nutrient deficiencies, and soil compaction and other physical disturbances. In sediments, nonchemical stressors may include salinity, seasonal cycles of inundation and drying, pH, nutrient deficiencies, and physical disturbance. To the extent possible, these nonchemical factors were considered both qualitatively and quantitatively (using statistical correlations) in the evaluation of risk at the individual sites investigated.

8.0 CONCLUSIONS OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

Conclusions of the BERA based on the characterization of risk to wetland and upland plants, fish and aquatic invertebrates, and birds and mammals are presented below.

8.1 PLANTS

Unacceptable risk to populations of wetland and upland plants, including special status species, at the Litigation Area is not indicated. Comparison of maximum soil and sediment concentrations of metals with the ORNL benchmarks and effects levels from the literature suggests that some unacceptable risk to individual plants may exist at selected locations in RASS 1 (Unit 6) and RASS 2 (Unit 12) on the marsh surface where elevated concentrations of metals are detected. Zinc, arsenic, copper and lead are the primary risk drivers for plants at these locations. Plant cover and diversity are very high on the marsh surface and the marsh surface is slowly accumulating cleaner sediment. Additional remedial action based on risk to plants is not warranted.

During the July 2001 site inspection tour, the Navy and the regulatory agencies observed an area of distressed vegetation in RASS 1. This area was along the berm separating the Litigation Area from GCC and Honeywell, Inc. property. At a risk management meeting in March 2002, the Navy proposed conducting a limited focused investigation, including soil and groundwater sampling, of this area to address the potential for contaminant migration from GCC and Honeywell, Inc. to Navy property. Details of this proposal are presented in Section 10.0 of the five-year review report. The results of this investigation will be used to assess if populations of marsh plants in this portion of RASS 1 are at risk and whether any additional action is needed.

8.2 FISH AND AQUATIC INVERTEBRATES

Population-level effects to fish and aquatic invertebrates from exposure to DDTs and PCBs and Aroclors in sediment at the Litigation Area are not indicated.

Some unacceptable risk of population-level effects to fish and aquatic invertebrates from exposure to metals in sediment and surface water may exist at selected locations in the main reach (Unit 10) and western arm (Unit 11) of Lost Slough based on the cooccurrence of:

- Toxicity in amphipod bioassays
- Unacceptable bioaccumulation potential (mercury is the greatest concern)
- Elevated concentrations of metals in sediment (arsenic, cadmium, and zinc are of greatest concern) and surface water (copper is of greatest concern) at some locations

The Navy proposes conducting a supplemental feasibility study to evaluate possible remedial alternatives for reducing risk posed by contaminated sediment in Unit 11 of Lost Slough (see Section 10.0 of the five-year review report).

High surface water and sediment concentrations of metals have been measured in the mosquito ditches in Unit 7, and the results of ditch-profile studies suggest the potential for mobilization and transport of contaminated sediment into Lost Slough. The Navy proposes conducting a supplemental feasibility study to evaluate possible remedial alternatives for reducing sediment transport in the Unit 7 ditches (see Section 10.0 of the five-year review report).

Migration of contaminants from RASS 3 to RASS 1 is an additional concern. Mobilization and increased bioavailability of metals from on-site sources (such as Nichols Creek) and off-site sources may present an ongoing risk to fish and aquatic invertebrates in the southern portion of RASS 1. The Navy proposes conducting a supplemental feasibility study to evaluate possible remedial alternatives for reducing the erosion potential of soil and sediment in Nichols Creek (see Section 10.0 of the five-year review report).

8.3 BIRDS AND MAMMALS

Population-level effects to birds and mammals from exposure to DDTs and PCBs and Aroclors in sediment or soil and prey at the Litigation Area are not indicated based on the analysis of existing data. However, during discussions with the regulatory agencies, some concern was raised about potential data gaps for PCBs in areas along the northern margin of RASS 3, bordering the Southern Pacific Transportation Company Railroad property, and along Nichols Creek downstream of the CPC property.

During a meeting in March 2002, the Navy proposed additional soil sampling for PCBs at locations along the railroad right-of-way and at locations along Nichols Creek (Appendix H). Details of this proposal are presented in Section 10.0 in the five-year review report.

Some unacceptable population-level risk from exposure to metals may exist for the California Black Rail (risk driver is zinc) and Suisun Song Sparrow (risk driver is selenium) along areas of the main reach (Units 9 and 10) and western arm of Lost Slough (Unit 11) and the ditches (Units 5 and 7). The Navy will evaluate risk reduction to the Black Rail as part of the supplemental feasibility studies proposed for Unit 11 and the Unit 7 ditches.

Some unacceptable risk is indicated for individual salt marsh harvest mice from arsenic at a small number of locations in Unit 6; however, unacceptable risk of population-level effects is not indicated for the harvest mouse. Additional remediation of the marsh surface is not warranted based on risk to individual harvest mice. Risk estimates at point locations were based on maximum concentrations in 6-inch vertical composite cores. Exposure potential for mice was determined to be low based on a detailed analysis of vertical profiles, showing higher contaminant concentrations buried several inches under cleaner soil that had accreted on the marsh surface. The dense layer of vegetation on the marsh surface serves as a barrier, limiting lateral migration of contaminants. As a result, the Navy concludes that the negative impacts of additional remediation over a wide area of the southeastern marsh surface in RASS 1 would outweigh any potential reduction in risk that could be obtained.

During a meeting in March 2002, the regulatory agencies raised concerns about an area of semilithified soil that was observed in RASS 4 during the July 2001 site inspection tour. The Navy has proposed to collect additional samples in this area to better characterize this material and determine whether it poses unacceptable risk to ecological receptors.

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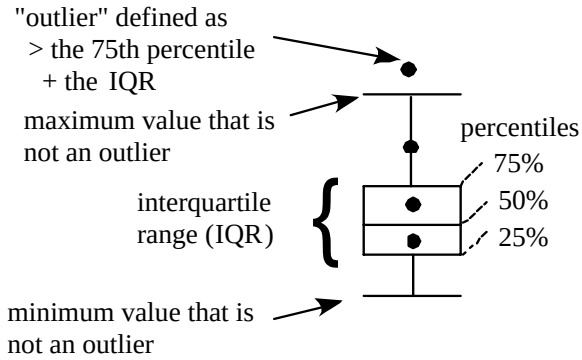
ATTACHMENT G1

SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA DURING MONITORING YEARS 1 THROUGH 5

Key for
Outlier Box Plots



shaded line through center of each plot is the grand mean across all locations

ATTACHMENT G1
SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

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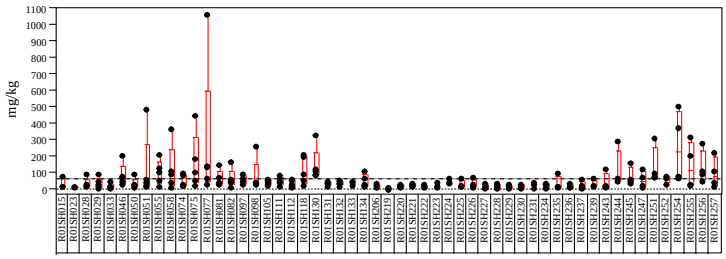

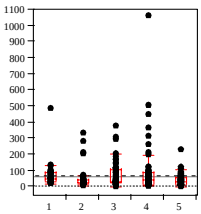

Location	Round 1	2	3	4	5
R01SH015	20.90	16.90	81.90	81.80	21.20
R01SH023	18.80		12.80	12.70	12.10
R01SH028	94.20	29.00	33.00	24.60	17.10
R01SH029	93.70	21.10	28.40	47.60	4.40
R01SH033	20.80	16.60	49.50	16.30	8.60
R01SH046	79.50	29.90	204.00	75.70	49.80
R01SH050	91.60	31.20	33.30	23.40	15.50
R01SH051	487.00	21.10	62.30	22.90	42.90
R01SH055	131.00	18.90	107.00	210.00	56.10
R01SH058	43.00	13.20	115.00	368.00	91.10
R01SH074	103.00	25.70	28.60	87.10	25.00
R01SH075	59.30	27.60	187.00	451.00	107.00
R01SH077	138.00	67.60	144.00	1,060.00	32.80
R01SH081	75.80	33.60	149.00	46.40	40.40
R01SH082	50.20	44.90	166.00	12.60	59.70
R01SH097	30.00		47.80	95.10	66.60
R01SH098	36.20	45.50	32.00	265.00	43.50
R01SH105	44.20	27.70	32.10	58.30	62.30
R01SH111	86.70	47.20	21.80	66.20	43.90
R01SH112	53.40	10.90	19.70	60.70	28.50
R01SH118	54.90	212.00	91.90	202.00	24.20
R01SH130	89.70	331.00	114.00	93.50	123.00
R01SH131	35.30	16.90	40.60	48.30	52.50
R01SH132	55.00	37.70	48.30	19.80	37.90
R01SH133	49.50	26.20	26.50	25.80	46.30
R01SH134	70.50	18.20	113.00	32.10	27.30
R01SH206	25.80	14.40	15.60	13.90	35.90
R01SH219		7.00	9.80	10.40	2.70

Location	Round 1	2	3	4	5
R01SH220		18.90	23.60	30.20	9.80
R01SH221		20.10	23.80	38.20	33.50
R01SH222		18.90	16.10	29.10	14.20
R01SH223		17.60	14.10	14.10	46.40
R01SH224		40.90	45.70	71.70	39.40
R01SH225		19.20	23.70	70.50	18.50
R01SH226		15.50	73.40	19.80	34.30
R01SH227		38.20	15.80	5.80	8.90
R01SH228		30.00	34.40	16.70	5.10
R01SH229		19.50	30.30	7.50	9.50
R01SH230		20.50	18.30	8.70	32.60
R01SH231		46.10	34.20	6.40	6.90
R01SH234		29.80	38.90	8.20	15.30
R01SH235		21.60	98.10	14.50	16.90
R01SH236		21.20	35.30	15.10	12.80
R01SH237		26.60	3.60	61.50	15.00
R01SH239		21.80	25.70	22.80	66.30
R01SH243		17.20	26.00	124.00	10.30
R01SH244		50.70	295.00	70.40	69.60
R01SH245		63.60	165.00	47.40	40.10
R01SH247		24.60	13.60	124.00	74.60
R01SH251		72.30	310.00	103.00	76.30
R01SH252		34.10	81.90	79.50	67.10
R01SH254		66.00	375.00	508.00	84.20
R01SH255		208.00	27.60	317.00	30.60
R01SH256		281.00	110.00	96.60	47.20
R01SH257		20.70	115.00	45.40	228.00

	Summary Statistics n	min	max	mean	S.D.
1	27	18.80	487.00	79.19	87.67
2	53	7.00	331.00	46.35	64.38
3	55	3.60	375.00	74.35	79.39
4	55	5.80	1,060.00	99.77	170.77
5	55	2.70	228.00	41.67	37.22

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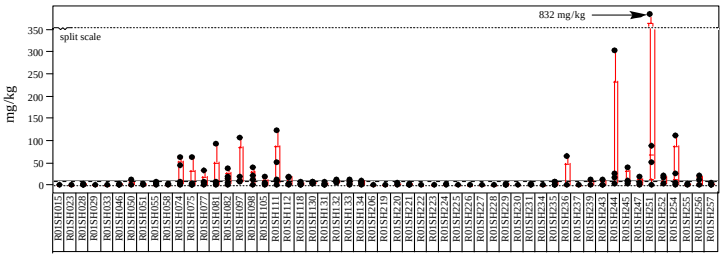
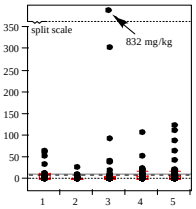




Location	Round 1	2	3	4	5
R01SH015	0.05	0.76	1.30	1.00	1.00
R01SH023	0.69		0.37	0.13	0.94
R01SH028	1.00	1.30	3.60	0.48	0.17
R01SH029	0.30	0.40	1.10	1.80	0.06
R01SH033	0.06	0.83	0.05	0.07	0.15
R01SH046	1.50	3.90	3.50	0.17	0.54
R01SH050	13.10	0.92	0.04	0.05	0.84
R01SH051	4.10	0.07	0.04	0.06	2.00
R01SH055	2.10	0.63	4.60	3.50	8.20
R01SH058	2.80	0.06	1.60	1.50	0.71
R01SH074	63.40	1.30	3.50	8.20	44.00
R01SH075	63.80	0.90	3.00	0.38	3.50
R01SH077	33.50	5.70	7.70	0.37	1.50
R01SH081	0.08	0.81	94.00	6.80	7.70
R01SH082	13.90	4.90	37.70	0.03	20.50
R01SH097	7.50		20.50	108.00	10.40
R01SH098	0.06	1.60	40.40	21.50	13.50
R01SH105	0.79	2.40	3.10	20.30	5.70
R01SH111	52.60	9.90	0.07	13.40	124.00
R01SH112	3.60	0.09	3.00	17.90	19.10
R01SH118	7.60	1.00	4.10	1.90	3.10
R01SH130	3.80	8.40	5.00	2.50	7.00
R01SH131	4.00	0.29	7.10	2.80	2.20
R01SH132	7.60	10.20	12.10	5.10	7.00
R01SH133	12.20	0.04	2.20	4.40	7.40
R01SH134	7.20	1.60	2.40	11.30	6.10
R01SH206		1.60	0.04	0.66	1.70
R01SH219		0.54	0.10	0.07	0.10

Location	Round 1	2	3	4	5
R01SH220		5.80	0.06	0.43	0.10
R01SH221		0.07	4.20	0.29	0.68
R01SH222		0.33	0.04	0.61	1.10
R01SH223		0.25	0.05	0.05	1.70
R01SH224		1.40	1.30	0.68	2.80
R01SH225		0.07	0.08	0.05	1.60
R01SH226		0.05	0.04	0.05	1.50
R01SH227		0.09	0.11	0.16	0.82
R01SH228		0.08	2.10	1.30	0.92
R01SH229		0.05	4.20	0.03	0.41
R01SH230		0.55	0.08	0.03	1.00
R01SH231		0.26	3.10	0.05	0.09
R01SH234		0.07	2.00	0.06	0.98
R01SH235		0.30	7.40	0.08	7.30
R01SH236		0.05	0.18	0.06	64.90
R01SH237		0.26	0.09	0.07	0.71
R01SH239		0.06	2.00	0.05	13.10
R01SH243		0.97	1.10	12.90	0.04
R01SH244		2.70	304.00	25.40	16.60
R01SH245		2.40	40.10	11.30	7.90
R01SH247		1.30	2.20	18.70	5.70
R01SH251		1.90	832.00	52.60	88.70
R01SH252		2.30	2.50	21.80	16.80
R01SH254		26.10	4.80	1.40	111.00
R01SH255		1.60	0.05	3.50	2.40
R01SH256		0.80	0.05	12.50	22.50
R01SH257		0.19	5.80	0.05	0.98

Round	Summary Statistics n	min	max	mean	S.D.
1	27	0.00	63.80	11.38	18.91
2	53	0.04	26.10	2.08	4.12
3	55	0.04	832.00	26.94	118.57
4	55	0.03	108.00	7.25	16.77
5	55	0.04	124.00	12.21	25.96

Notes:

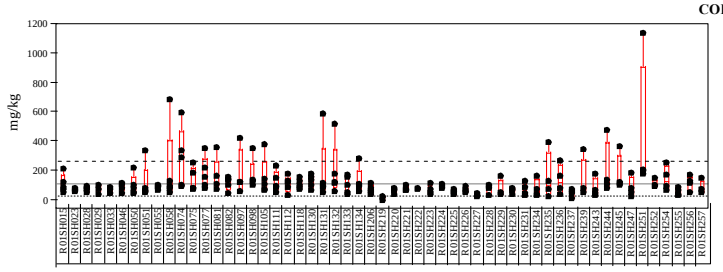
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

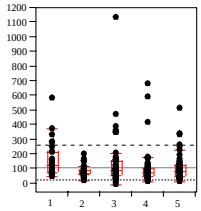
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MAIN SLOUGH

COPPER





Location	Round 1	2	3	4	5
R01SH015	56.10	75.20	215.00	126.00	91.10
R01SH023	85.20		63.30	69.40	71.80
R01SH028	84.80	82.40	93.70	77.80	53.70
R01SH029	76.10	77.70	102.00	104.00	37.40
R01SH033	77.90	77.80	90.60	47.00	45.40
R01SH046	82.50	84.30	118.00	107.00	47.80
R01SH050	222.00	83.70	101.00	48.50	57.60
R01SH051	336.00	65.50	59.60	53.10	82.30
R01SH055	95.40	67.00	100.00	89.20	96.00
R01SH058	82.10	56.60	128.00	689.00	98.50
R01SH074	291.00	99.40	95.70	596.00	340.00
R01SH075	258.00	85.00	184.00	82.10	75.30
R01SH077	219.00	161.00	351.00	83.60	99.70
R01SH081	165.00	77.90	357.00	112.00	112.00
R01SH082	137.00	100.00	159.00	45.10	145.00
R01SH097	61.40		126.00	423.00	124.00
R01SH098	99.50	104.00	351.00	140.00	129.00
R01SH105	381.00	75.30	69.60	144.00	112.00
R01SH111	154.00	92.00	55.20	94.20	238.00
R01SH112	129.00	33.50	86.10	179.00	121.00
R01SH118	129.00	159.00	86.90	105.00	75.20
R01SH130	69.50	155.00	105.00	180.00	135.00
R01SH131	586.00	116.00	93.40	89.90	56.70
R01SH132	125.00	118.00	180.00	59.30	518.00
R01SH133	169.00	42.70	53.20	102.00	157.00
R01SH134	284.00	97.60	61.80	58.60	112.00
R01SH206	82.30	64.70	41.20	54.20	119.00
R01SH219		25.80	0.35	20.20	22.30

Location	Round 1	2	3	4	5
R01SH220		71.80	78.50	70.70	42.00
R01SH221		67.00	100.00	74.10	67.80
R01SH222		74.80	81.10	82.40	81.20
R01SH223		72.00	37.30	54.40	117.00
R01SH224		84.90	109.00	93.10	92.50
R01SH225		61.10	41.20	55.20	78.00
R01SH226		62.10	94.30	54.00	76.30
R01SH227		50.40	32.50	23.50	36.50
R01SH228		92.80	103.00	78.60	35.00
R01SH229		51.10	163.00	39.20	40.20
R01SH230		66.90	75.90	37.30	82.30
R01SH231		87.90	134.00	36.00	48.30
R01SH234		76.00	163.00	42.30	34.10
R01SH235		73.10	392.00	28.60	128.00
R01SH236		78.70	162.00	38.50	268.00
R01SH237		76.60	14.20	63.20	48.50
R01SH239		79.00	80.90	54.50	344.00
R01SH243		48.30	70.90	181.00	33.40
R01SH244		82.80	479.00	112.00	137.00
R01SH245		126.00	367.00	116.00	105.00
R01SH247		53.80	24.90	183.00	78.60
R01SH251		208.00	1,140.00	180.00	197.00
R01SH252		97.40	102.00	103.00	149.00
R01SH254		171.00	67.80	96.90	253.00
R01SH255		70.50	32.40	91.20	42.70
R01SH256		114.00	55.60	129.00	172.00
R01SH257		73.60	150.00	51.20	55.30

Round	Summary Statistics n	min	max	mean	S.D.
1	27	56.10	586.00	168.07	122.87
2	53	25.80	208.00	85.82	34.60
3	55	0.35	1,140.00	143.26	170.90
4	55	20.20	689.00	111.78	121.47
5	55	22.30	518.00	113.01	90.64

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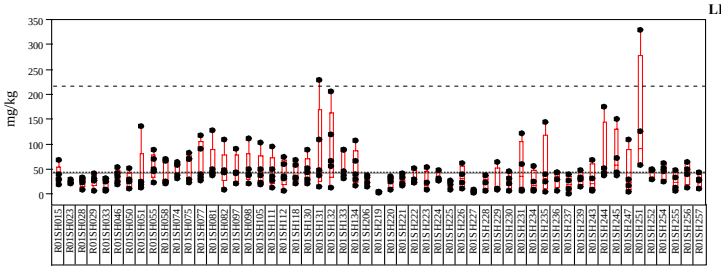

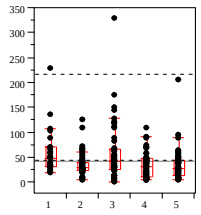

Location	Round 1	2	3	4	5
R01SH015	20.60	30.60	69.50	42.20	31.30
R01SH023	31.60		25.30	22.60	23.60
R01SH028	33.90	28.70	34.60	24.40	11.40
R01SH029	34.10	29.80	43.20	29.50	7.90
R01SH033	33.30	26.40	32.70	9.00	10.50
R01SH046	37.70	28.20	56.10	44.40	20.30
R01SH050	54.60	31.70	27.20	12.10	12.80
R01SH051	138.00	28.20	14.30	20.50	24.90
R01SH055	72.40	24.90	90.00	47.00	52.80
R01SH058	28.20	22.40	68.80	72.60	27.80
R01SH074	62.70	34.00	40.00	59.40	65.60
R01SH075	73.30	31.10	85.80	72.20	25.60
R01SH077	34.90	40.80	120.00	94.00	29.80
R01SH081	52.90	43.10	130.00	40.40	44.80
R01SH082	49.10	45.00	112.00	11.80	46.10
R01SH097	22.20		45.50	93.00	44.40
R01SH098	41.80	39.40	114.00	51.60	23.30
R01SH105	105.00	20.90	25.10	51.20	40.60
R01SH111	51.70	29.30	15.90	38.40	97.80
R01SH112	38.00	8.40	33.20	77.50	62.10
R01SH118	59.40	70.50	36.00	33.00	23.20
R01SH130	23.50	46.40	54.40	91.10	30.60
R01SH131	231.00	111.00	49.70	39.10	16.80
R01SH132	68.70	58.20	121.00	14.70	209.00
R01SH133	91.90	39.90	34.10	48.40	90.30
R01SH134	109.00	67.90	30.60	19.90	42.60
R01SH206	36.40	24.40	17.30	17.80	39.60
R01SH219		6.00	4.70	6.10	6.50

Location	Round 1	2	3	4	5
R01SH220		27.50	37.30	32.70	10.40
R01SH221		23.80	44.40	35.20	19.20
R01SH222		25.50	54.60	32.20	25.80
R01SH223		26.00	11.40	11.80	56.10
R01SH224		29.20	49.80	33.80	29.30
R01SH225		28.30	10.00	21.20	29.00
R01SH226		25.60	64.30	13.60	41.40
R01SH227		11.60	5.60	6.60	8.70
R01SH228		40.20	39.00	24.70	8.20
R01SH229		13.00	67.00	9.90	10.20
R01SH230		22.70	48.70	9.50	32.50
R01SH231		61.80	124.00	9.60	11.40
R01SH234		28.10	58.40	10.60	9.00
R01SH235		27.20	147.00	7.60	41.30
R01SH236		31.70	45.20	9.10	46.00
R01SH237		29.50	1.70	41.20	12.20
R01SH239		35.00	31.40	17.80	49.20
R01SH243		11.20	33.90	70.40	8.60
R01SH244		40.30	178.00	44.50	54.60
R01SH245		73.80	152.00	46.80	39.80
R01SH247		32.10	7.60	112.00	20.00
R01SH251		128.00	331.00	59.80	59.90
R01SH252		50.60	31.10	50.50	51.40
R01SH254		53.10	26.70	47.70	64.60
R01SH255		34.60	8.00	50.50	14.50
R01SH256		67.30	15.00	41.80	52.10
R01SH257		31.70	45.40	12.90	30.20

Round	Summary Statistics n	min	max	mean	S.D.
1	27	20.60	231.00	60.59	44.78
2	53	6.00	128.00	37.29	22.43
3	55	1.70	331.00	58.17	55.89
4	55	6.10	112.00	37.23	25.67
5	55	6.50	209.00	36.32	31.48

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

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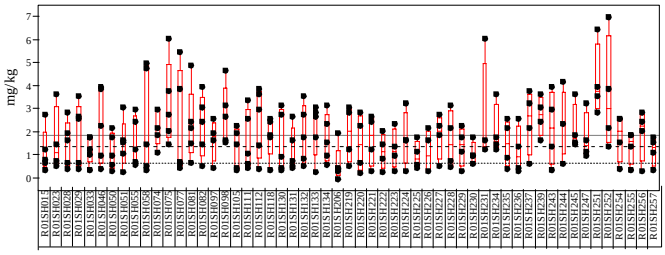

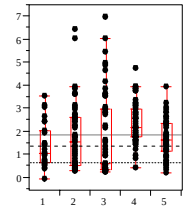

Location	Round 1	2	3	4	5
R01SH015	0.85	1.30	0.39	2.80	0.70
R01SH023	0.80		3.70	1.50	0.55
R01SH028	0.70	0.46	2.90	2.00	1.70
R01SH029	0.70	0.46	3.60	2.60	2.70
R01SH033	1.05	1.80	0.40	1.80	1.30
R01SH046	0.44	2.30	3.90	4.00	1.00
R01SH050	1.00	1.80	0.35	2.20	0.60
R01SH051	1.10	1.60	0.30	3.10	1.70
R01SH055	1.30	0.75	0.60	3.00	2.50
R01SH058	0.55	0.40	5.00	4.80	1.50
R01SH074	1.15	3.00	3.00	2.20	1.90
R01SH075	2.10	2.80	6.10	3.80	1.50
R01SH077	0.75	0.50	5.50	3.90	0.65
R01SH081	1.55	0.70	4.90	2.20	2.50
R01SH082	2.50	4.00	0.55	1.50	3.10
R01SH097	2.00		0.50	2.60	1.70
R01SH098	3.20	2.70	4.70	1.70	1.60
R01SH105	1.50	0.48	0.41	2.00	2.30
R01SH111	0.65	1.10	0.50	3.40	2.60
R01SH112	1.45	3.70	0.43	3.90	3.00
R01SH118	2.50	2.60	0.38	1.80	1.90
R01SH130	0.48	2.80	0.41	3.20	0.95
R01SH131	2.70	0.57	0.47	1.70	0.80
R01SH132	3.60	0.56	2.80	0.88	1.80
R01SH133	3.10	1.80	0.28	2.90	2.70
R01SH134	0.60	3.20	1.00	1.60	2.40
R01SH206		0.44	0.33	0.50	2.00
R01SH219		0.59	3.10	1.30	2.90

Location	Round 1	2	3	4	5
R01SH220		0.72	2.90	2.30	0.27
R01SH221		2.50	0.35	2.70	1.30
R01SH222		0.90	0.31	2.10	1.50
R01SH223		1.40	0.36	1.00	2.40
R01SH224		1.70	0.35	3.30	1.70
R01SH225		0.48	0.60	1.80	1.20
R01SH226		0.33	0.35	1.70	2.20
R01SH227		0.57	2.30	2.80	1.90
R01SH228		0.52	2.20	3.20	0.80
R01SH229		2.30	0.34	1.80	1.20
R01SH230		1.00	0.65	1.80	1.00
R01SH231		6.10	1.70	1.70	1.30
R01SH234		3.70	1.30	1.80	1.50
R01SH235		2.60	0.44	2.20	0.93
R01SH236		0.34	1.40	2.60	0.49
R01SH237		2.20	0.65	3.80	3.30
R01SH239		3.10	3.70	2.50	1.70
R01SH243		1.40	3.00	4.00	0.41
R01SH244		0.66	4.20	2.40	2.40
R01SH245		3.70	1.60	1.90	1.50
R01SH247		1.20	1.00	3.30	1.70
R01SH251		6.50	3.60	2.90	4.00
R01SH252		3.90	7.00	2.20	1.40
R01SH254		2.60	0.44	2.60	1.60
R01SH255		1.90	0.40	1.90	1.40
R01SH256		2.50	0.36	2.10	2.90
R01SH257		0.38	1.15	1.60	1.80

Round	n	min	max	mean	S.D.
1	27	0.00	3.60	1.42	0.96
2	53	0.33	6.50	1.84	1.43
3	55	0.28	7.00	1.80	1.80
4	55	0.50	4.80	2.42	0.89
5	55	0.27	4.00	1.72	0.81

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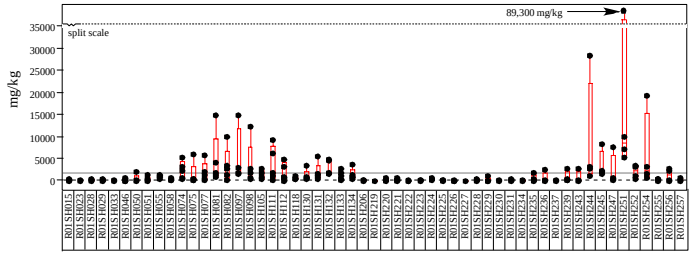

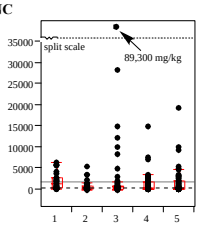

Location	Round 1	2	3	4	5
R01SH015	203.00	259.00	513.00	416.00	241.00
R01SH023	305.00		182.00	194.00	204.00
R01SH028	386.00	419.00	612.00	345.00	65.00
R01SH029	260.00	283.00	496.00	598.00	55.90
R01SH033	367.00	306.00	390.00	66.00	50.80
R01SH046	182.00	627.00	740.00	271.00	119.00
R01SH050	2,250.00	429.00	233.00	69.40	68.60
R01SH051	1,400.00	312.00	87.40	75.50	595.00
R01SH055	953.00	581.00	1,410.00	1,250.00	1,380.00
R01SH058	508.00	233.00	346.00	844.00	256.00
R01SH074	2,460.00	527.00	910.00	3,300.00	5,580.00
R01SH075	6,140.00	410.00	543.00	402.00	532.00
R01SH077	5,840.00	1,470.00	2,110.00	286.00	483.00
R01SH081	4,210.00	961.00	15,000.00	1,890.00	1,510.00
R01SH082	2,920.00	1,440.00	10,100.00	381.00	3,640.00
R01SH097	1,780.00		3,040.00	15,000.00	2,070.00
R01SH098	612.00	696.00	12,400.00	3,000.00	2,050.00
R01SH105	2,030.00	656.00	530.00	2,890.00	1,070.00
R01SH111	6,480.00	1,360.00	240.00	2,000.00	9,500.00
R01SH112	944.00	69.80	779.00	3,380.00	5,050.00
R01SH118	1,330.00	612.00	733.00	873.00	456.00
R01SH130	925.00	3,580.00	851.00	664.00	881.00
R01SH131	5,750.00	1,480.00	1,620.00	1,030.00	539.00
R01SH132	1,840.00	1,740.00	4,970.00	1,890.00	4,700.00
R01SH133	2,860.00	401.00	679.00	1,380.00	2,050.00
R01SH134	3,740.00	1,010.00	599.00	1,390.00	1,120.00
R01SH206	268.00	147.00	180.00	236.00	356.00
R01SH219		47.20	49.80	45.10	47.80

Location	Round 1	2	3	4	5
R01SH220		745.00	326.00	213.00	90.40
R01SH221		229.00	737.00	239.00	106.00
R01SH222		200.00	237.00	319.00	203.00
R01SH223		222.00	107.00	65.80	361.00
R01SH224		478.00	360.00	690.00	472.00
R01SH225		223.00	131.00	143.00	287.00
R01SH226		208.00	324.00	70.60	211.00
R01SH227		22.80	60.00	58.60	79.00
R01SH228		309.00	512.00	267.00	76.30
R01SH229		72.00	1,160.00	86.50	77.00
R01SH230		246.00	174.00	89.70	198.00
R01SH231		414.00	582.00	91.70	64.70
R01SH234		259.00	367.00	100.00	76.90
R01SH235		225.00	1,860.00	79.90	628.00
R01SH236		241.00	426.00	89.20	2,590.00
R01SH237		313.00	0.13	203.00	148.00
R01SH239		348.00	502.00	256.00	2,920.00
R01SH243		250.00	429.00	2,880.00	76.10
R01SH244		1,270.00	28,500.00	2,900.00	3,310.00
R01SH245		2,320.00	8,420.00	2,290.00	1,710.00
R01SH247		495.00	446.00	7,770.00	692.00
R01SH251		5,560.00	89,300.00	7,260.00	10,200.00
R01SH252		1,230.00	526.00	3,630.00	3,410.00
R01SH254		3,460.00	744.00	1,630.00	19,500.00
R01SH255		477.00	97.40	613.00	434.00
R01SH256		440.00	133.00	2,510.00	2,980.00
R01SH257		423.00	835.00	113.00	182.00

Round	n	min	max	mean	S.D.
1	27	182.00	6,480.00	2,109.00	2,005.56
2	53	22.80	5,560.00	768.60	1,001.99
3	55	0.13	89,300.00	3,593.43	12,682.82
4	55	45.10	15,000.00	1,433.16	2,475.55
5	55	47.80	19,500.00	1,740.95	3,257.22

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

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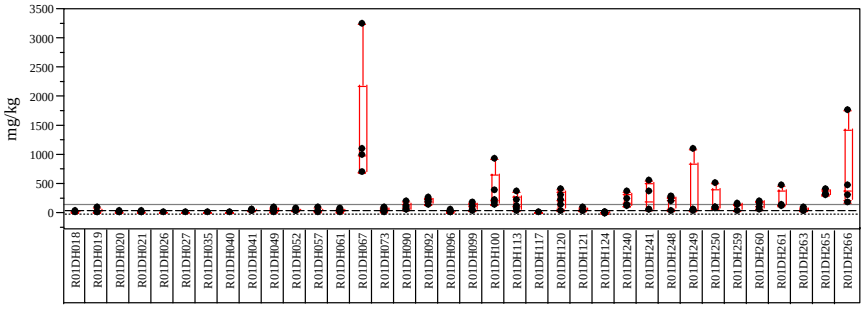
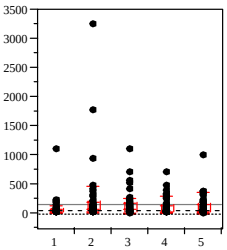


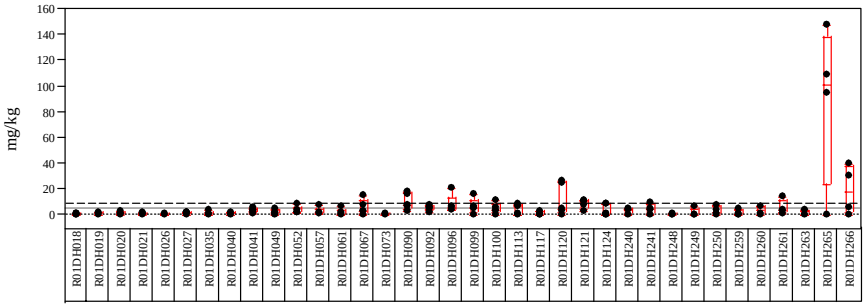


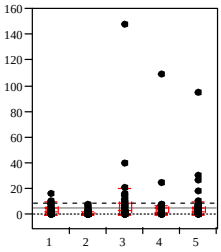
Location	Round 1	2	3	4	5
R01DH018	35.30	50.90	31.00	22.60	23.80
R01DH019	16.70	100.00	11.30	16.20	10.90
R01DH020	16.70	35.10	18.10	13.30	14.50
R01DH021	19.50	35.30	11.30	26.30	19.80
R01DH026	30.10	18.90	15.10	16.80	15.10
R01DH027	18.90	19.40	26.10	20.20	20.80
R01DH035	19.10	30.90	14.00	11.40	26.60
R01DH040	18.50	23.70	13.50	13.40	15.90
R01DH041	46.00	72.90	40.90	39.60	52.60
R01DH049	74.00	106.00	31.80	14.50	51.00
R01DH052	50.30	42.50	88.20	36.80	36.80
R01DH057	93.90	51.80	43.00	47.00	20.50
R01DH061	10.90	32.60	88.90	54.70	49.50
R01DH067	1,110.00	3,260.00	717.00	706.00	1,000.00
R01DH073	73.70	43.50	25.40	101.00	63.50
R01DH090	63.10	209.00	116.00	110.00	70.70
R01DH092	216.00	153.00	233.00	276.00	178.00
R01DH096	31.60	19.90	68.80	26.70	27.50

Location	Round 1	2	3	4	5
R01DH099	184.00	135.00	121.00	62.00	51.00
R01DH100	138.00	928.00	219.00	390.00	183.00
R01DH113	227.00	365.00	32.00	93.20	119.00
R01DH117	21.80	22.60	12.00	23.20	21.60
R01DH120	39.50	416.00	141.00	315.00	239.00
R01DH121	43.00	102.00	44.30	32.40	46.80
R01DH124	25.20	27.00	8.60	18.10	4.80
R01DH240		142.00	125.00	242.00	366.00
R01DH241		65.70	570.00	53.10	365.00
R01DH248		283.00	266.00	38.60	210.00
R01DH249		54.80	1,110.00	50.40	55.10
R01DH250		97.00	524.00	89.40	112.00
R01DH259		147.00	136.00	175.00	44.30
R01DH260		211.00	160.00	97.10	67.70
R01DH261		473.00	135.00	150.00	151.00
R01DH263		38.60	68.20	38.50	98.20
R01DH265		308.00	422.00	328.00	339.00
R01DH266		1,770.00	189.00	476.00	317.00

Round	Summary Statistics n	min	max	mean	S.D.
1	25	10.90	1,110.00	104.91	218.53
2	36	18.90	3,260.00	274.75	605.98
3	36	8.60	1,110.00	163.24	235.15
4	36	11.40	706.00	117.35	155.86
5	36	4.80	1,000.00	124.67	184.06

CADMIUM





Location	Round 1	2	3	4	5
R01DH018	0.81	1.20	0.12	0.55	1.00
R01DH019	2.10	1.80	0.09	0.50	0.57
R01DH020	1.10	0.06	0.08	1.10	3.30
R01DH021	0.88	0.08	0.09	0.95	2.60
R01DH026	0.62	0.05	0.07	1.30	1.10
R01DH027	1.90	0.10	2.40	0.92	2.60
R01DH035	0.10	0.07	1.50	1.60	3.70
R01DH040	0.08	0.07	2.00	2.40	2.00
R01DH041	3.30	1.10	4.40	6.00	3.30
R01DH049	4.90	2.30	2.70	0.51	1.50
R01DH052	2.10	2.10	8.80	3.70	2.70
R01DH057	8.40	2.10	2.40	1.10	1.30
R01DH061	0.06	0.05	7.00	1.30	2.20
R01DH067	3.10	0.30	15.70	8.30	3.10
R01DH073	0.16	0.60	0.09	0.17	1.20
R01DH090	3.30	8.40	16.00	7.10	18.50
R01DH092	5.50	5.00	8.00	2.40	5.70
R01DH096	6.00	6.60	21.40	4.30	4.00

Location	Round 1	2	3	4	5
R01DH099	16.50	0.12	7.30	4.90	6.40
R01DH100	3.60	0.28	11.30	4.10	5.70
R01DH113	8.90	0.09	1.30	6.90	7.70
R01DH117	0.13	1.50	0.13	3.00	3.40
R01DH120	3.40	0.57	4.90	25.40	26.70
R01DH121	10.70	2.80	11.60	8.20	10.90
R01DH124	8.90	0.86	9.10	1.50	0.21
R01DH240		0.31	5.40	4.50	4.20
R01DH241		0.35	10.10	4.80	4.50
R01DH248		0.31	1.10	0.06	0.63
R01DH249		0.37	6.80	0.08	0.46
R01DH250		0.45	4.30	0.89	8.10
R01DH259		0.40	1.70	0.17	4.70
R01DH260		0.32	1.60	7.00	7.10
R01DH261		3.40	14.30	1.30	4.00
R01DH263		0.16	0.09	0.08	4.60
R01DH265		0.36	148.00	109.00	94.60
R01DH266		0.56	40.10	6.00	30.70

Round	Summary Statistics n	min	max	mean	S.D.
1	25	0.06	16.50	3.86	4.11
2	36	0.05	8.40	1.25	1.91
3	36	0.07	148.00	10.33	24.90
4	36	0.06	109.00	6.45	18.16
5	36	0.21	94.60	7.92	16.30

Notes:

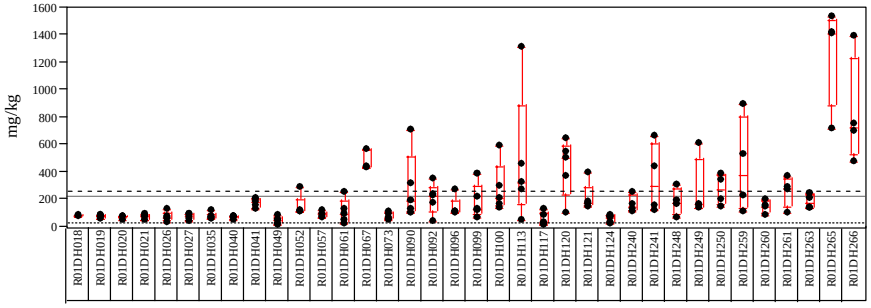
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

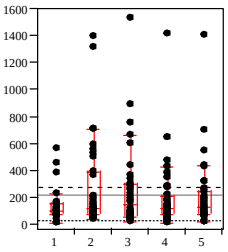
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 1 DITCHES

COPPER



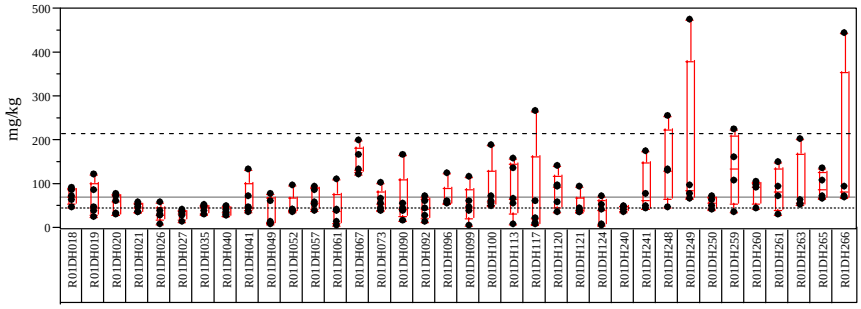


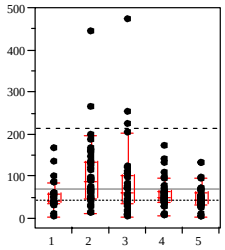
Location	Round 1	2	3	4	5
R01DH018	80.90	84.30	83.70	84.50	85.20
R01DH019	83.70	93.00	60.30	85.30	66.80
R01DH020	84.30	54.30	84.20	84.00	81.10
R01DH021	83.20	55.70	57.60	83.60	95.30
R01DH026	130.00	62.80	67.40	36.80	80.40
R01DH027	78.40	61.80	102.00	41.10	93.70
R01DH035	72.50	59.30	73.50	77.40	125.00
R01DH040	77.50	68.80	80.00	56.50	75.80
R01DH041	156.00	214.00	131.00	187.00	201.00
R01DH049	49.00	88.80	50.80	16.00	31.00
R01DH052	112.00	116.00	290.00	116.00	124.00
R01DH057	121.00	100.00	94.40	79.60	71.20
R01DH061	24.50	53.20	261.00	101.00	133.00
R01DH067	569.00	566.00	445.00	432.00	438.00
R01DH073	101.00	117.00	63.60	56.10	75.20
R01DH090	133.00	712.00	105.00	192.00	324.00
R01DH092	238.00	44.70	233.00	356.00	180.00
R01DH096	113.00	113.00	275.00	114.00	104.00

Location	Round 1	2	3	4	5
R01DH099	392.00	218.00	67.90	135.00	122.00
R01DH100	171.00	595.00	302.00	145.00	213.00
R01DH113	461.00	1,320.00	49.90	279.00	329.00
R01DH117	21.40	129.00	30.80	85.10	33.40
R01DH120	110.00	507.00	373.00	649.00	550.00
R01DH121	167.00	403.00	179.00	148.00	190.00
R01DH124	82.10	87.20	38.10	75.10	25.30
R01DH240		118.00	173.00	133.00	261.00
R01DH241		124.00	670.00	156.00	442.00
R01DH248		194.00	313.00	71.60	168.00
R01DH249		172.00	610.00	139.00	161.00
R01DH250		154.00	349.00	388.00	208.00
R01DH259		533.00	898.00	232.00	113.00
R01DH260		157.00	203.00	87.10	151.00
R01DH261		375.00	109.00	289.00	276.00
R01DH263		139.00	215.00	140.00	249.00
R01DH265		716.00	1,540.00	1,420.00	1,410.00
R01DH266		1,400.00	760.00	481.00	705.00

Round	Summary Statistics n	min	max	mean	S.D.
1	25	21.40	569.00	148.46	133.71
2	36	44.70	1,400.00	277.94	331.31
3	36	30.80	1,540.00	262.17	306.81
4	36	16.00	1,420.00	201.44	251.50
5	36	25.30	1,410.00	221.98	253.20

LEAD





Location	Round 1	2	3	4	5
R01DH018	85.70	91.40	71.80	63.60	47.00
R01DH019	38.40	122.00	84.80	45.90	25.20
R01DH020	32.10	73.00	76.60	60.90	31.70
R01DH021	37.10	52.50	46.20	59.50	36.00
R01DH026	57.00	31.90	38.40	9.30	28.30
R01DH027	34.40	28.20	41.10	12.90	34.90
R01DH035	37.70	48.60	30.30	52.70	49.40
R01DH040	36.50	49.70	42.30	30.00	27.70
R01DH041	44.30	133.00	37.00	48.30	73.20
R01DH049	61.60	76.40	11.30	8.20	12.60
R01DH052	37.40	42.20	98.10	38.10	42.30
R01DH057	86.20	94.50	58.00	52.10	38.00
R01DH061	6.70	13.40	112.00	42.30	37.90
R01DH067	168.00	199.00	122.00	133.00	134.00
R01DH073	102.00	66.60	54.80	39.50	44.20
R01DH090	38.70	167.00	17.60	44.70	56.10
R01DH092	61.00	15.00	71.10	27.90	43.60
R01DH096	57.20	60.50	125.00	56.70	54.20

Location	Round 1	2	3	4	5
R01DH099	61.50	116.00	5.30	47.20	40.10
R01DH100	48.70	188.00	71.80	59.80	55.30
R01DH113	135.00	158.00	8.20	56.40	67.40
R01DH117	10.50	266.00	21.60	62.40	7.10
R01DH120	37.50	94.80	57.20	142.00	97.60
R01DH121	36.60	93.20	41.40	37.40	45.60
R01DH124	52.40	72.70	8.80	43.00	6.60
R01DH240		47.20	41.40	49.50	37.40
R01DH241		43.40	77.50	175.00	50.70
R01DH248		131.00	255.00	45.90	132.00
R01DH249		97.80	475.00	77.10	67.00
R01DH250		63.50	72.80	41.60	51.20
R01DH259		162.00	226.00	109.00	36.70
R01DH260		90.70	106.00	98.60	45.50
R01DH261		149.00	31.40	72.20	95.70
R01DH263		62.80	204.00	56.40	51.80
R01DH265		136.00	107.00	67.00	71.30
R01DH266		444.00	71.80	94.80	70.10

Round	Summary Statistics n	min	max	mean	S.D.
1	25	6.70	168.00	56.17	36.10
2	36	13.40	444.00	105.03	81.01
3	36	5.30	475.00	83.91	88.58
4	36	8.20	175.00	60.03	35.39
5	36	6.60	134.00	51.26	28.55

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 1 DITCHES

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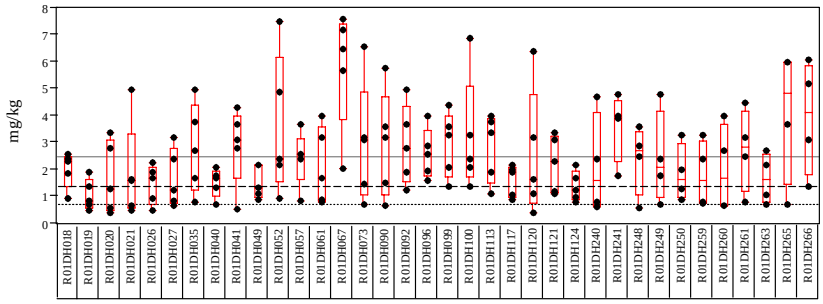
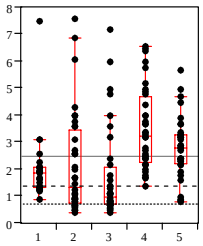


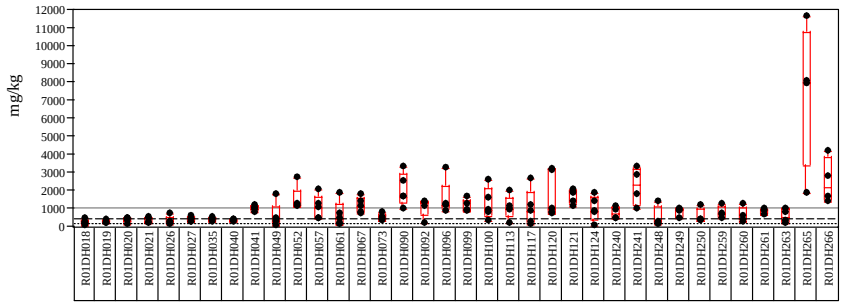


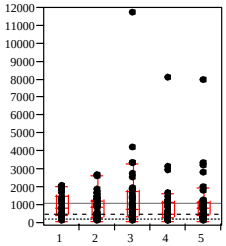
Location	Round 1	2	3	4	5
R01DH018	1.85	2.60	0.95	2.40	2.30
R01DH019	1.40	0.47	0.70	1.90	0.85
R01DH020	1.30	0.40	0.60	3.40	2.80
R01DH021	1.65	0.51	0.65	5.00	1.60
R01DH026	2.25	0.92	0.50	1.70	1.90
R01DH027	1.25	0.68	0.85	3.20	2.40
R01DH035	1.70	2.70	0.80	3.80	5.00
R01DH040	1.35	2.10	0.70	1.70	1.80
R01DH041	3.10	4.30	0.55	3.70	2.80
R01DH049	1.35	0.88	1.10	2.20	2.20
R01DH052	7.50	0.95	2.20	4.90	2.40
R01DH057	2.60	2.60	0.85	3.70	2.40
R01DH061	0.90	1.70	4.00	3.20	0.80
R01DH067	2.05	7.60	7.20	6.50	5.70
R01DH073	3.10	1.45	0.70	6.60	3.20
R01DH090	1.50	3.60	0.65	5.80	3.20
R01DH092	1.90	1.25	5.00	2.80	3.70
R01DH096	1.95	4.00	1.60	2.60	2.90

Location	Round 1	2	3	4	5
R01DH099	2.10	3.60	1.40	4.40	3.30
R01DH100	2.10	6.90	2.40	1.40	3.30
R01DH113	1.90	3.80	1.10	4.00	3.40
R01DH117	1.90	2.00	1.05	2.20	0.90
R01DH120	1.65	1.10	0.38	6.40	3.20
R01DH121	1.20	3.10	1.10	3.40	2.30
R01DH124	1.25	1.70	0.80	2.20	1.00
R01DH240		0.62	0.80	2.40	4.70
R01DH241		4.00	4.80	1.80	3.90
R01DH248		0.60	3.60	2.50	2.90
R01DH249		0.73	1.80	4.80	2.40
R01DH250		0.89	1.30	2.00	3.30
R01DH259		0.80	0.75	3.30	2.40
R01DH260		0.65	0.65	4.00	2.70
R01DH261		0.79	3.20	2.50	4.50
R01DH263		1.05	0.70	2.70	2.20
R01DH265		0.72	6.00	6.00	3.70
R01DH266		6.10	1.40	5.20	3.10

Round	Summary Statistics n	min	max	mean	S.D.
1	25	0.90	7.50	2.03	1.26
2	36	0.40	7.60	2.16	1.88
3	36	0.38	7.20	1.75	1.70
4	36	1.40	6.60	3.51	1.50
5	36	0.80	5.70	2.81	1.12

ZINC





Location	Round 1	2	3	4	5
R01DH018	441.00	200.00	99.80	254.00	213.00
R01DH019	385.00	227.00	279.00	244.00	201.00
R01DH020	483.00	118.00	355.00	320.00	438.00
R01DH021	518.00	210.00	220.00	278.00	438.00
R01DH026	732.00	223.00	296.00	129.00	293.00
R01DH027	481.00	234.00	576.00	257.00	401.00
R01DH035	439.00	269.00	354.00	368.00	520.00
R01DH040	433.00	325.00	426.00	242.00	295.00
R01DH041	1,170.00	1,000.00	941.00	1,070.00	825.00
R01DH049	1,770.00	492.00	365.00	74.40	237.00
R01DH052	1,220.00	1,240.00	2,750.00	1,140.00	1,130.00
R01DH057	2,080.00	1,040.00	435.00	1,260.00	480.00
R01DH061	118.00	179.00	1,840.00	500.00	709.00
R01DH067	1,410.00	832.00	1,830.00	1,150.00	759.00
R01DH073	797.00	476.00	564.00	310.00	316.00
R01DH090	1,020.00	1,680.00	2,550.00	1,660.00	3,320.00
R01DH092	1,340.00	1,310.00	1,430.00	169.00	1,120.00
R01DH096	1,280.00	1,170.00	3,300.00	1,200.00	879.00

Location	Round 1	2	3	4	5
R01DH099	1,650.00	943.00	1,290.00	878.00	859.00
R01DH100	826.00	2,600.00	1,620.00	361.00	904.00
R01DH113	2,010.00	950.00	203.00	1,030.00	1,150.00
R01DH117	259.00	2,650.00	165.00	1,210.00	887.00
R01DH120	802.00	985.00	711.00	3,160.00	3,210.00
R01DH121	2,040.00	1,430.00	1,890.00	1,150.00	1,960.00
R01DH124	1,860.00	1,420.00	768.00	867.00	77.60
R01DH240		486.00	1,140.00	485.00	960.00
R01DH241		981.00	3,330.00	2,900.00	1,780.00
R01DH248		158.00	1,400.00	275.00	209.00
R01DH249		1,000.00	953.00	435.00	876.00
R01DH250		390.00	345.00	409.00	1,200.00
R01DH259		1,280.00	683.00	456.00	730.00
R01DH260		409.00	269.00	590.00	1,260.00
R01DH261		865.00	955.00	644.00	969.00
R01DH263		322.00	803.00	199.00	1,030.00
R01DH265		1,850.00	11,700.00	8,070.00	7,950.00
R01DH266		1,670.00	4,220.00	1,430.00	2,780.00

Round	Summary Statistics n	min	max	mean	S.D.
1	25	118.00	2,080.00	1,022.56	614.26
2	36	118.00	2,650.00	878.17	659.86
3	36	99.80	11,700.00	1,418.22	2,035.65
4	36	74.40	8,070.00	977.07	1,402.92
5	36	77.60	7,950.00	1,149.04	1,406.34

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MARSH SURFACE

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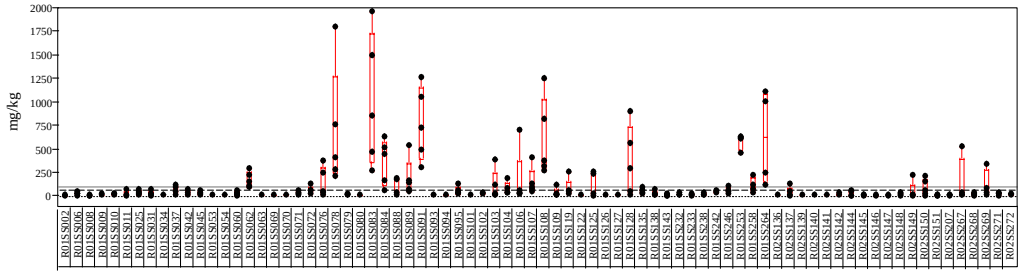
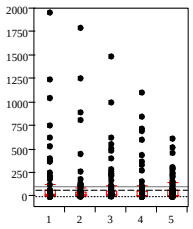




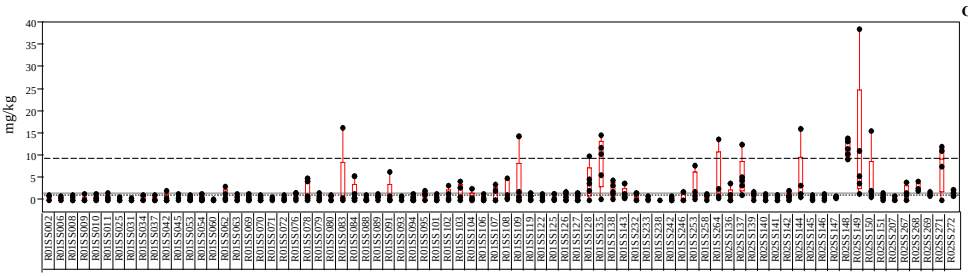
Location	Round 1	2	3	4	5
R01SS002	20.20	13.40	21.90	11.80	9.80
R01SS006	34.00	29.30	47.90	8.60	24.70
R01SS008	9.00	14.80	15.30	8.70	9.60
R01SS009	24.70	18.50	12.00	14.90	14.40
R01SS010	33.10	28.10	33.10	15.40	28.30
R01SS011	73.60	18.80	20.60	6.50	9.70
R01SS025	75.90	23.50	20.90	55.60	43.70
R01SS031	70.10	32.60	28.10	12.40	10.30
R01SS034		20.10	18.70	17.90	14.60
R01SS037	11.10	56.10	122.00	92.90	94.40
R01SS042	42.80	42.90	19.80	20.40	73.70
R01SS045	31.60	39.60	61.70	17.90	14.20
R01SS053	17.30	15.90	15.60	15.10	17.10
R01SS054	15.50	15.10	17.00	12.50	11.80
R01SS060	35.10	13.40	64.50	29.40	10.70
R01SS062	229.00	93.10	302.00	112.00	156.00
R01SS063	17.80	19.40	15.50	13.20	14.30
R01SS069	15.10	13.00	13.50	13.10	13.50
R01SS070	13.10	14.10	13.20	19.70	12.60
R01SS071	42.90	58.50	66.50	16.10	33.70
R01SS072	61.70	135.00	31.30	30.90	60.80
R01SS076	377.00	22.30	248.00	55.50	41.90
R01SS078	759.00	1,800.00	412.00	284.00	214.00
R01SS079	17.60	27.40	14.50	11.90	15.80
R01SS080	13.50	11.10	14.00	13.40	13.80
R01SS083	1,960.00	273.00	1,500.00	861.00	470.00

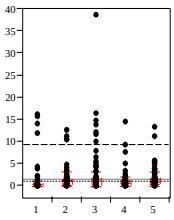
Location	Round 1	2	3	4	5
R01SS084	632.00	66.40	515.00	452.00	172.00
R01SS088	195.00	16.60	182.00	34.80	44.60
R01SS089	545.00	149.00	76.30	167.00	53.80
R01SS091	1,050.00	1,270.00	493.00	734.00	304.00
R01SS093	21.90	15.20	15.30	13.30	18.40
R01SS094	16.10	15.40	14.30	16.40	12.40
R01SS095	137.00	45.70	30.00	60.00	34.20
R01SS101	12.90	15.40	15.90	14.20	12.10
R01SS102	43.10	33.10	32.10	29.80	30.90
R01SS103	385.00	14.20	31.20	14.20	116.00
R01SS104	36.00	191.00	36.40	90.80	87.70
R01SS106	31.70	61.30	36.70	705.00	25.30
R01SS107	418.00	55.90	95.10	74.40	131.00
R01SS108	1,250.00	819.00	274.00	380.00	324.00
R01SS109	20.10	23.00	18.80	123.00	17.40
R01SS119	259.00	46.80	51.70	28.90	60.00
R01SS122	18.00	15.70	17.50	11.60	13.00
R01SS125	32.40	24.10	234.00	10.10	262.00
R01SS126	16.30	13.90	17.20	16.90	13.30
R01SS127	16.60	17.20	14.60	11.70	11.90
R01SS128	13.10	903.00	569.00	55.40	294.00
R01SS135	38.30	24.10	66.50	102.00	67.70
R01SS138	21.80	33.10	20.50	13.80	77.70
R01SS143	10.20	12.90	29.00	7.90	12.40
R01SS232		15.50	37.70	11.20	13.10
R01SS233		21.70	30.20	18.30	6.60

Location	Round 1	2	3	4	5
R01SS238		21.40	40.60	11.30	12.80
R01SS242		40.70	44.60	60.60	47.40
R01SS246		111.00	33.70	65.80	50.40
R01SS253		458.00	636.00	607.00	622.00
R01SS258		38.60	118.00	76.90	230.00
R01SS264		122.00	1,010.00	1,110.00	249.00
R02SS136	13.80	16.10	14.00	12.50	12.70
R02SS137	10.80	137.00	46.40	47.60	21.10
R02SS139	18.10	17.90	16.50	13.60	20.70
R02SS140	17.30	16.00	16.60	12.20	16.60
R02SS141	16.10	14.70	13.30	11.10	13.30
R02SS142	43.50	17.50	14.30	11.80	14.00
R02SS144	7.90	48.20	63.60	6.30	7.80
R02SS145	17.40	16.10	16.50	7.20	13.30
R02SS146	5.80	16.50	15.20	12.80	18.10
R02SS147	17.10	11.80	13.30	14.30	10.60
R02SS148	27.40	24.90	36.70	10.00	22.40
R02SS149	5.00	17.90	230.00	18.40	11.00
R02SS150	212.00	58.70	31.40	8.30	158.00
R02SS151	7.70	19.30	14.30	8.70	18.30
R02SS207	11.60	9.00	6.80	3.90	13.60
R02SS267		11.60	36.80	16.40	528.00
R02SS268		19.30	29.50	40.60	10.00
R02SS269		35.00	16.80	346.00	82.30
R02SS271		8.10	33.60	38.20	27.10
R02SS272		28.10	19.80	15.60	11.50

Round	Summary Statistics n	min	max	mean	S.D.
1	64	5.00	1,960.00	150.81	334.65
2	78	8.10	1,800.00	103.89	278.40
3	78	6.80	1,500.00	111.18	233.09
4	78	3.90	1,110.00	96.85	207.92
5	78	6.60	622.00	75.52	121.61

CADMIUM





Location	Round 1	2	3	4	5
R01SS002	0.05	0.07	0.04	1.20	1.10
R01SS006	0.06	0.06	0.06	0.48	1.10
R01SS008	0.05	1.30	0.05	0.88	0.74
R01SS009	0.07	1.40	0.09	0.05	0.07
R01SS010	0.10	0.17	0.11	0.53	1.40
R01SS011	0.08	1.70	0.06	0.69	0.53
R01SS025	0.07	0.91	0.06	0.06	0.18
R01SS031	0.09	0.11	0.07	0.52	0.18
R01SS034		1.30	0.04	0.07	0.11
R01SS037	0.10	0.21	0.05	1.30	0.19
R01SS042	0.07	2.20	0.07	0.67	0.18
R01SS045		1.60	0.08	0.05	0.67
R01SS053	0.03	1.20	0.03	0.76	0.41
R01SS054	0.03	1.50	0.03	0.67	0.23
R01SS060	0.14	0.16	0.10	0.25	0.12
R01SS062	0.07	0.41	3.20	0.68	1.50
R01SS063	0.03	1.40	0.02	0.71	0.77
R01SS069	0.03	1.40	0.03	0.75	0.25
R01SS070	0.03	1.30	0.02	1.00	0.55
R01SS071	0.90	0.32	0.08	0.11	0.07
R01SS072	0.14	1.30	0.12	0.18	0.66
R01SS076	0.14	1.50	1.80	0.67	1.70
R01SS078	0.11	0.50	4.30	1.10	5.10
R01SS079	0.03	1.70	0.03	1.00	0.66
R01SS080	0.03	1.20	0.02	0.97	0.94
R01SS083	0.08	0.14	16.40	0.59	0.48

Location	Round 1	2	3	4	5
R01SS084	0.08	0.55	5.60	0.54	1.60
R01SS088	0.08	0.40	1.20	0.07	0.19
R01SS089	0.12	0.76	0.99	0.83	1.50
R01SS091	0.10	0.40	6.40	0.10	1.00
R01SS093	0.03	0.13	0.03	1.00	0.71
R01SS094	0.03	1.50	0.02	0.79	0.24
R01SS095	2.30	1.60	0.05	0.13	1.20
R01SS101	0.03	1.50	0.02	0.85	0.24
R01SS102	0.07	0.55	1.50	0.28	3.30
R01SS103	4.30	0.91	0.06	0.09	2.90
R01SS104	0.53	2.80	0.06	0.18	0.06
R01SS106	0.05	0.43	0.08	0.46	1.50
R01SS107	0.15	3.60	0.13	0.04	2.20
R01SS108	0.66	0.39	5.10	5.10	1.20
R01SS109	0.03	1.90	0.03	14.60	0.81
R01SS119	0.11	0.29	1.10	1.70	0.98
R01SS122	0.03	1.40	0.03	0.78	1.20
R01SS125	0.06	0.39	1.60	0.32	1.50
R01SS126	0.03	1.40	0.02	1.90	0.78
R01SS127	0.03	1.70	0.02	1.60	1.10
R01SS128	0.03	4.90	10.10	2.20	3.80
R01SS135	12.00	10.60	14.70	0.38	5.80
R01SS138	1.50	3.30	2.00	0.31	4.70
R01SS143	0.58	1.10	1.60	0.73	3.90
R01SS232		1.40	0.10	0.03	1.70
R01SS233		1.10	0.08	0.05	0.43

Location	Round 1	2	3	4	5
R01SS238		0.12	0.06	0.05	0.06
R01SS242		0.09	0.59	0.05	1.10
R01SS246		1.90	0.09	0.06	0.06
R01SS253		0.44	8.00	1.00	2.00
R01SS258		1.50	1.30	0.06	1.00
R01SS264		0.55	13.70	0.99	2.80
R02SS136	0.03	1.20	0.02	1.30	3.80
R02SS137	1.20	12.50	4.70	3.40	5.40
R02SS139	0.03	1.60	1.40	1.30	2.10
R02SS140	0.03	1.30	0.02	1.50	0.97
R02SS141	0.03	1.20	0.02	1.20	0.92
R02SS142	2.30	0.02	0.96	0.85	1.00
R02SS144	16.10	1.50	3.50	0.81	0.76
R02SS145	0.02	0.13	0.73	0.27	1.20
R02SS146	0.02	1.20	0.65	1.20	1.40
R02SS147	0.78	0.93	0.87	0.74	0.65
R02SS148	14.00	10.60	11.70	9.20	13.40
R02SS149	3.80	11.10	38.60	1.50	5.60
R02SS150	15.60	1.20	2.20	0.92	2.10
R02SS151	0.53	1.80	0.79	0.05	1.30
R02SS207	0.02	0.02	0.02	0.04	0.95
R02SS267		4.10	0.05	1.70	1.20
R02SS268		2.20	4.30	2.80	2.60
R02SS269		1.90	1.40	1.10	1.10
R02SS271		0.02	12.20	7.70	11.10
R02SS272		2.50	1.70	1.20	0.96

Round	Summary Statistics n	min	max	mean	S.D.
1	63	0.02	16.10	1.27	3.57
2	78	0.02	12.50	1.69	2.42
3	78	0.02	38.60	2.42	5.55
4	78	0.03	14.60	1.18	2.12
5	78	0.06	13.40	1.67	2.21

Notes:

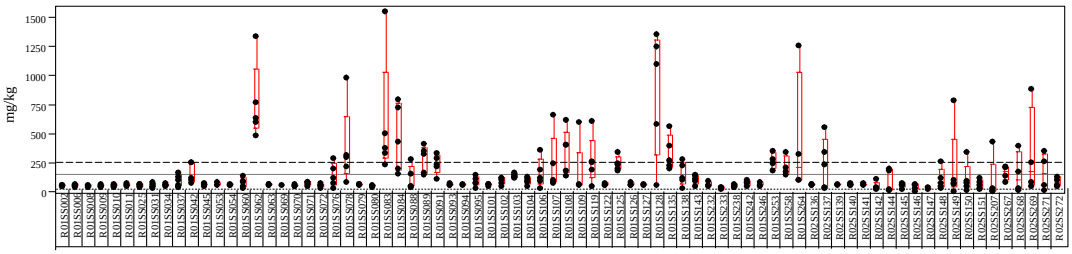
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

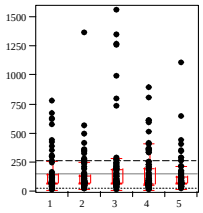
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MARSH SURFACE

COPPER





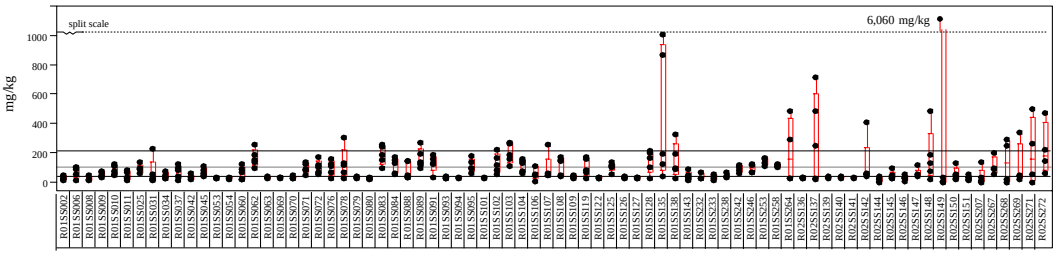
Location	Round 1	2	3	4	5
R01SS002	70.50	66.10	68.20	71.30	59.90
R01SS006	64.20	76.90	74.50	55.60	68.40
R01SS008	67.30	69.70	69.00	54.90	54.50
R01SS009	68.10	58.70	57.70	76.10	61.00
R01SS010	61.20	81.30	84.30	54.90	73.20
R01SS011	86.40	75.80	74.80	63.90	64.00
R01SS025	76.90	53.60	58.00	73.80	76.70
R01SS031	99.90	55.80	82.60	63.70	42.20
R01SS034		69.60	60.70	85.30	67.60
R01SS037	53.30	117.00	179.00	72.50	138.00
R01SS042	264.00	136.00	86.20	118.00	268.00
R01SS045	77.10	79.20	85.40	61.70	80.70
R01SS053	72.10	68.50	74.70	72.20	97.10
R01SS054	70.50	73.50	78.00	72.10	74.90
R01SS060	111.00	62.00	149.00	100.00	48.20
R01SS062	784.00	496.00	1,350.00	616.00	647.00
R01SS063	74.90	74.70	77.00	70.70	76.40
R01SS069	69.70	71.50	67.30	70.40	72.90
R01SS070	65.70	70.40	68.00	62.50	77.40
R01SS071	76.10	76.80	94.90	57.90	99.70
R01SS072	65.20	93.30	72.70	42.80	73.50
R01SS076	299.00	45.60	212.00	135.00	90.40
R01SS078	310.00	327.00	992.00	234.00	99.50
R01SS079	75.90	78.20	75.50	73.80	76.40
R01SS080	64.10	57.70	64.50	71.60	74.30
R01SS083	390.00	249.00	1,560.00	513.00	348.00

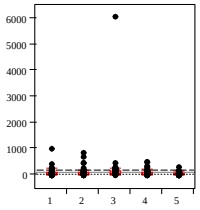
Location	Round 1	2	3	4	5
R01SS084	441.00	214.00	734.00	813.00	169.00
R01SS088	168.00	62.80	291.00	55.70	61.60
R01SS089	424.00	361.00	159.00	337.00	182.00
R01SS091	306.00	346.00	249.00	231.00	123.00
R01SS093	86.00	67.70	77.10	74.40	72.50
R01SS094	76.60	79.20	76.10	73.70	75.20
R01SS095	126.00	91.60	47.70	159.00	88.90
R01SS101	79.30	76.90	76.70	66.60	76.40
R01SS102	64.60	88.90	132.00	115.00	129.00
R01SS103	159.00	146.00	134.00	138.00	174.00
R01SS104	140.00	104.00	65.40	94.90	124.00
R01SS106	42.20	129.00	208.00	371.00	109.00
R01SS107	678.00	89.20	97.90	256.00	112.00
R01SS108	627.00	415.00	196.00	420.00	155.00
R01SS109	78.90	76.00	79.10	616.00	72.80
R01SS119	621.00	264.00	279.00	204.00	57.90
R01SS122	72.50	86.90	82.00	68.80	70.30
R01SS125	247.00	357.00	198.00	257.00	209.00
R01SS126	74.10	75.00	82.30	94.50	70.10
R01SS127	83.20	82.20	77.50	69.80	74.20
R01SS128	70.40	1,370.00	1,260.00	596.00	1,110.00
R01SS135	577.00	283.00	237.00	215.00	413.00
R01SS138	117.00	236.00	136.00	43.00	291.00
R01SS143	128.00	58.70	151.00	106.00	159.00
R01SS232		74.10	111.00	62.60	63.60
R01SS233		53.80	32.90	51.30	45.50

Location	Round 1	2	3	4	5
R01SS238		57.10	79.60	54.70	68.20
R01SS242		94.20	58.10	84.90	116.00
R01SS246		98.40	71.70	74.40	65.00
R01SS253		261.00	195.00	364.00	296.00
R01SS258		163.00	222.00	189.00	352.00
R01SS264		118.00	1,270.00	334.00	119.00
R02SS136	73.50	79.40	73.40	75.80	76.10
R02SS137	42.70	572.00	252.00	352.00	53.50
R02SS139	76.10	78.90	80.10	76.20	72.00
R02SS140	84.50	74.70	83.90	79.00	72.00
R02SS141	89.00	72.00	67.70	74.60	74.10
R02SS142	121.00	54.70	41.10	36.30	44.30
R02SS144	25.80	193.00	217.00	23.00	32.90
R02SS145	71.20	80.50	93.00	33.40	73.80
R02SS146	19.80	77.60	76.60	72.80	43.80
R02SS147	53.80	32.90	36.50	38.20	33.00
R02SS148	130.00	280.00	90.10	60.10	41.40
R02SS149	18.80	87.00	802.00	80.10	115.00
R02SS150	355.00	58.20	109.00	24.50	89.80
R02SS151	35.20	96.80	67.60	41.90	129.00
R02SS207	47.70	28.10	19.20	13.40	443.00
R02SS267		147.00	227.00	102.00	221.00
R02SS268		42.10	191.00	411.00	29.30
R02SS269		99.70	61.40	894.00	269.00
R02SS271		26.50	272.00	362.00	73.40
R02SS272		146.00	114.00	67.40	63.00

Round	Summary Statistics n	min	max	mean	S.D.
1	64	18.80	784.00	160.13	176.5
2	78	26.50	1,370.00	143.47	178.1
3	78	19.20	1,560.00	205.86	313.3
4	78	13.40	894.00	162.20	182.9
5	78	29.30	1,110.00	132.87	154.1

LEAD





Location	Round 1	2	3	4	5
R01SS002	49.80	28.10	53.50	34.90	18.70
R01SS006	110.00	97.10	107.00	22.60	63.40
R01SS008	29.40	29.60	50.70	20.00	20.60
R01SS009	78.20	57.20	44.20	84.00	43.40
R01SS010	85.40	60.00	115.00	56.90	133.00
R01SS011	72.70	34.30	85.80	41.40	22.10
R01SS025	142.00	70.00	70.70	95.50	103.00
R01SS031	232.00	36.10	62.30	28.20	17.00
R01SS034		55.00	35.30	81.40	36.80
R01SS037	21.70	89.70	131.00	50.50	105.00
R01SS042	40.30	28.50	27.00	25.80	69.40
R01SS045	67.80	119.00	89.60	47.60	50.70
R01SS053	36.40	34.20	36.70	37.30	33.60
R01SS054	34.40	34.70	42.10	35.60	28.50
R01SS060	92.90	26.60	131.00	72.20	25.40
R01SS062	195.00	101.00	260.00	155.00	141.00
R01SS063	49.10	43.10	38.80	36.90	36.00
R01SS069	41.40	32.30	35.20	30.30	37.30
R01SS070	33.90	33.50	34.10	53.80	32.60
R01SS071	95.70	91.40	144.00	53.40	131.00
R01SS072	108.00	177.00	72.90	58.20	127.00
R01SS076	116.00	31.60	166.00	132.00	76.50
R01SS078	123.00	140.00	312.00	76.00	35.00
R01SS079	39.70	44.40	35.40	33.80	33.50
R01SS080	31.60	26.10	34.50	39.20	33.70
R01SS083	261.00	106.00	252.00	193.00	156.00

Location	Round 1	2	3	4	5
R01SS084	140.00	64.50	178.00	155.00	65.70
R01SS088	152.00	43.70	154.00	51.80	41.80
R01SS089	277.00	199.00	146.00	104.00	132.00
R01SS091	132.00	196.00	138.00	164.00	43.10
R01SS093	44.90	31.50	39.60	35.60	32.80
R01SS094	42.60	40.50	42.20	39.20	34.20
R01SS095	183.00	101.00	68.00	145.00	99.80
R01SS101	39.00	39.30	42.00	40.70	31.30
R01SS102	63.10	89.20	228.00	124.00	173.00
R01SS103	117.00	272.00	277.00	193.00	162.00
R01SS104	80.80	140.00	69.80	166.00	152.00
R01SS106	11.80	61.80	114.00	118.00	52.50
R01SS107	260.00	55.00	65.40	67.50	55.80
R01SS108	182.00	150.00	51.20	157.00	44.10
R01SS109	42.50	37.10	50.10	55.70	34.70
R01SS119	165.00	78.00	178.00	85.60	32.10
R01SS122	40.10	33.00	42.20	31.00	33.40
R01SS125	113.00	117.00	121.00	147.00	63.70
R01SS126	42.20	38.70	44.40	41.80	33.90
R01SS127	38.00	36.10	37.00	31.90	30.10
R01SS128	32.60	219.00	205.00	112.00	170.00
R01SS135	1,010.00	872.00	199.00	45.30	132.00
R01SS138	99.60	201.00	95.90	30.10	332.00
R01SS143	37.30	28.20	99.20	54.20	19.10
R01SS232		32.00	76.00	36.10	33.30
R01SS233		47.80	30.30	61.00	21.70

Location	Round 1	2	3	4	5
R01SS238		49.90	75.80	42.60	37.60
R01SS242		111.00	68.20	88.40	124.00
R01SS246		133.00	74.00	124.00	77.20
R01SS253		139.00	118.00	171.00	168.00
R01SS258		108.00	126.00	115.00	130.00
R01SS264		32.70	295.00	493.00	31.80
R02SS136	36.90	36.70	38.80	37.70	33.50
R02SS137	24.20	724.00	491.00	255.00	36.50
R02SS139	45.70	37.00	39.50	43.10	34.50
R02SS140	38.20	37.00	45.90	36.00	32.70
R02SS141	40.40	30.60	33.40	31.70	32.40
R02SS142	414.00	59.60	67.00	62.90	43.80
R02SS144	8.20	27.50	50.20	30.70	15.20
R02SS145	41.20	35.00	51.70	102.00	31.40
R02SS146	10.60	34.90	43.00	33.00	62.20
R02SS147	121.00	60.50	58.40	58.10	48.90
R02SS148	190.00	491.00	79.80	137.00	26.00
R02SS149	6.80	14.20	6,060.00	37.80	9.50
R02SS150	140.00	60.30	32.10	26.80	54.10
R02SS151	17.30	41.40	59.70	23.60	37.90
R02SS207	37.00	18.80	13.40	7.90	144.00
R02SS267		93.80	204.00	59.90	102.00
R02SS268		23.30	255.00	300.00	7.80
R02SS269		52.60	48.60	345.00	29.70
R02SS271		6.80	266.00	509.00	61.70
R02SS272		480.00	229.00	148.00	66.20

Round	Summary Statistics n	min	max	mean	S.D.
1	64	6.80	1,010.00	104.76	139.1
2	78	6.80	872.00	99.85	142.6
3	78	13.40	6,060.00	181.82	679.8
4	78	7.90	509.00	92.40	92.9
5	78	7.80	332.00	65.96	54.9

Notes:

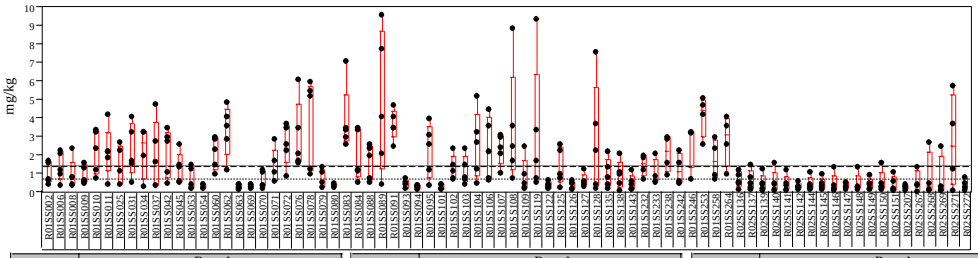
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

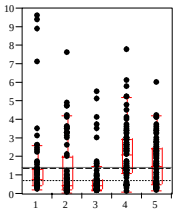
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MARSH SURFACE

SELENIUM





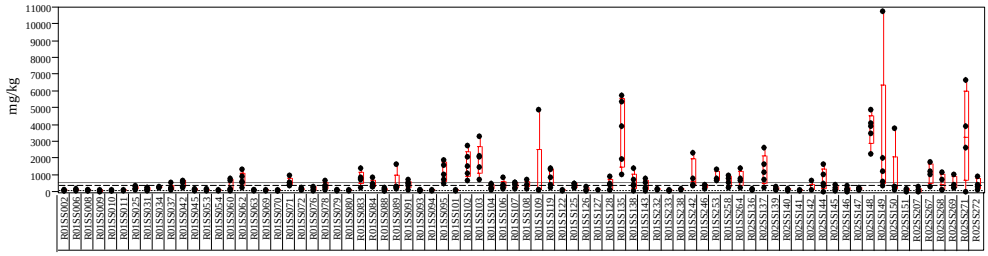
Location	Round 1	2	3	4	5
R01SS002	0.75	0.42	0.69	1.70	1.60
R01SS006	1.00	0.40	1.20	2.30	2.10
R01SS008	0.85	0.44	0.41	2.40	0.85
R01SS009	1.35	0.53	0.65	1.60	0.55
R01SS010	1.25	3.30	0.80	2.40	3.40
R01SS011	2.20	4.20	0.45	2.20	1.90
R01SS025	1.15	0.45	0.46	2.70	2.30
R01SS031	1.55	4.10	0.55	1.70	3.30
R01SS034		3.30	0.33	3.30	2.00
R01SS037	1.65	0.41	0.40	4.80	2.80
R01SS042	1.10	3.50	0.50	3.00	2.80
R01SS045	1.40	0.54	0.60	2.60	1.50
R01SS053	0.46	0.29	0.21	1.30	1.50
R01SS054	0.47	0.27	0.20	0.46	0.43
R01SS060	2.35	1.00	1.50	3.00	2.90
R01SS062	1.20	4.90	4.10	2.90	3.60
R01SS063	0.47	0.27	0.19	0.45	0.25
R01SS069	0.44	0.28	0.20	0.43	0.35
R01SS070	0.41	0.25	0.41	1.20	1.10
R01SS071	1.10	0.64	0.60	2.90	1.70
R01SS072	2.60	3.50	0.90	3.70	2.30
R01SS076	1.70	3.50	1.60	6.10	2.10
R01SS078	1.30	1.00	5.50	5.20	6.00
R01SS079	0.55	0.29	0.26	1.40	1.10
R01SS080	0.48	0.26	0.46	0.46	0.36
R01SS083	7.10	2.60	3.00	3.50	3.40

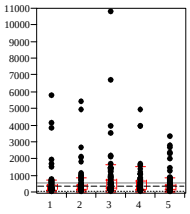
Location	Round 1	2	3	4	5
R01SS084	1.20	1.15	0.55	3.40	3.50
R01SS088	2.60	0.80	0.55	2.40	2.00
R01SS089	9.60	2.10	0.47	7.80	4.10
R01SS091	3.50	4.70	3.50	4.10	2.50
R01SS093	0.55	0.25	0.20	0.47	0.77
R01SS094	0.42	0.27	0.17	0.41	0.33
R01SS095	3.10	1.20	0.38	4.00	2.60
R01SS101	0.44	0.25	0.17	0.47	0.21
R01SS102	1.15	0.76	0.75	2.40	1.50
R01SS103	0.70	0.85	0.47	1.50	2.40
R01SS104	1.30	3.30	0.48	5.20	2.70
R01SS106	0.80	3.60	0.65	4.50	2.20
R01SS107	2.45	3.10	1.05	2.10	3.00
R01SS108	8.90	0.78	1.70	3.60	2.50
R01SS109	0.50	0.28	0.22	2.50	0.99
R01SS119	9.40	0.55	0.80	3.40	1.70
R01SS122	0.47	0.27	0.22	0.41	0.64
R01SS125	1.00	0.77	0.30	2.60	2.30
R01SS126	0.48	0.24	0.17	0.50	0.64
R01SS127	0.55	0.32	0.45	1.30	0.60
R01SS128	0.43	7.60	0.20	2.30	3.70
R01SS135	0.85	0.46	0.25	1.40	2.20
R01SS138	1.00	0.09	0.50	1.10	2.10
R01SS143	1.20	0.20	0.17	0.47	0.59
R01SS232		2.00	0.75	1.20	1.90
R01SS233		0.58	0.60	2.10	0.90

Location	Round 1	2	3	4	5
R01SS238		3.00	0.94	2.90	1.60
R01SS242		0.59	0.49	2.30	1.60
R01SS246		3.30	0.70	3.20	3.20
R01SS253		4.70	5.10	2.60	4.20
R01SS258		0.75	0.95	3.00	2.40
R01SS264		3.60	1.00	2.60	4.10
R02SS136	0.49	0.97	0.18	1.20	0.55
R02SS137	0.48	0.85	0.18	1.50	0.28
R02SS139	0.47	0.11	0.20	1.30	0.50
R02SS140	0.45	0.13	0.18	1.60	0.50
R02SS141	0.50	0.11	0.18	1.20	0.37
R02SS142	0.36	0.14	0.33	0.62	0.28
R02SS144	0.43	0.25	0.17	1.10	0.34
R02SS145	0.37	0.30	0.16	1.00	0.50
R02SS146	0.37	0.13	0.18	1.40	0.23
R02SS147	0.35	0.15	0.50	0.56	0.28
R02SS148	0.36	0.27	0.16	1.40	0.27
R02SS149	0.43	0.25	0.17	0.95	0.49
R02SS150	0.35	0.15	1.60	0.26	0.48
R02SS151	0.25	0.12	0.16	1.10	0.60
R02SS207	0.35	0.23	0.34	0.11	0.45
R02SS267		0.04	0.40	1.40	0.42
R02SS268		0.12	0.48	2.70	0.16
R02SS269		0.11	0.17	2.50	0.34
R02SS271		0.13	3.70	5.80	1.30
R02SS272		0.12	0.52	0.85	0.28

Round	n	min	max	mean	S.D.
1	64	0.25	9.60	1.46	2.05
2	78	0.04	7.60	1.25	1.58
3	78	0.16	5.50	0.78	1.07
4	78	0.11	7.80	2.19	1.51
5	78	0.16	6.00	1.62	1.27

ZINC





Location	Round 1	2	3	4	5
R01SS002	179.00	149.00	202.00	188.00	127.00
R01SS006	157.00	212.00	214.00	113.00	139.00
R01SS008	171.00	148.00	175.00	122.00	115.00
R01SS009	165.00	147.00	123.00	117.00	60.30
R01SS010	110.00	119.00	164.00	94.40	140.00
R01SS011	172.00	170.00	124.00	118.00	130.00
R01SS025	341.00	253.00	449.00	194.00	236.00
R01SS031	282.00	190.00	331.00	206.00	109.00
R01SS034		301.00	378.00	384.00	281.00
R01SS037	187.00	300.00	601.00	239.00	252.00
R01SS042	678.00	756.00	288.00	392.00	582.00
R01SS045	205.00	248.00	151.00	141.00	197.00
R01SS053	165.00	161.00	165.00	143.00	222.00
R01SS054	166.00	158.00	177.00	160.00	135.00
R01SS060	263.00	204.00	860.00	715.00	137.00
R01SS062	291.00	956.00	1,410.00	612.00	671.00
R01SS063	173.00	199.00	172.00	138.00	183.00
R01SS069	175.00	149.00	152.00	130.00	133.00
R01SS070	145.00	140.00	147.00	184.00	136.00
R01SS071	638.00	447.00	1,020.00	637.00	516.00
R01SS072	179.00	253.00	292.00	174.00	163.00
R01SS076	116.00	172.00	277.00	371.00	352.00
R01SS078	310.00	403.00	730.00	437.00	204.00
R01SS079	168.00	180.00	155.00	141.00	169.00
R01SS080	146.00	134.00	151.00	174.00	159.00
R01SS083	780.00	288.00	1,460.00	850.00	947.00

Location	Round 1	2	3	4	5
R01SS084	560.00	353.00	912.00	410.00	376.00
R01SS088	201.00	116.00	312.00	215.00	123.00
R01SS089	363.00	316.00	360.00	1,700.00	256.00
R01SS091	209.00	600.00	774.00	559.00	432.00
R01SS093	203.00	143.00	163.00	140.00	137.00
R01SS094	172.00	170.00	168.00	137.00	136.00
R01SS095	1,970.00	1,100.00	529.00	1,670.00	823.00
R01SS101	175.00	155.00	164.00	130.00	133.00
R01SS102	754.00	1,170.00	2,160.00	1,560.00	2,790.00
R01SS103	1,550.00	2,150.00	2,170.00	818.00	3,380.00
R01SS104	204.00	297.00	246.00	459.00	565.00
R01SS106	239.00	312.00	898.00	441.00	472.00
R01SS107	598.00	464.00	631.00	262.00	303.00
R01SS108	469.00	464.00	501.00	794.00	251.00
R01SS109	173.00	172.00	183.00	4,940.00	157.00
R01SS119	511.00	899.00	1,450.00	1,380.00	328.00
R01SS122	167.00	182.00	186.00	120.00	143.00
R01SS125	557.00	434.00	304.00	562.00	306.00
R01SS126	179.00	158.00	195.00	362.00	146.00
R01SS127	182.00	165.00	188.00	155.00	166.00
R01SS128	156.00	560.00	994.00	186.00	472.00
R01SS135	5,790.00	5,410.00	3,980.00	1,100.00	1,990.00
R01SS138	413.00	809.00	469.00	128.00	1,440.00
R01SS143	245.00	115.00	333.00	602.00	866.00
R01SS232		209.00	211.00	270.00	252.00
R01SS233		137.00	119.00	167.00	118.00

Location	Round 1	2	3	4	5
R01SS238		249.00	221.00	248.00	161.00
R01SS242		424.00	468.00	836.00	2,380.00
R01SS246		454.00	502.00	469.00	235.00
R01SS253		833.00	1,430.00	738.00	717.00
R01SS258		1,040.00	628.00	856.00	310.00
R01SS264		737.00	1,440.00	287.00	839.00
R02SS136	174.00	167.00	171.00	214.00	196.00
R02SS137	295.00	2,670.00	1,700.00	1,210.00	765.00
R02SS139	176.00	179.00	241.00	164.00	385.00
R02SS140	180.00	172.00	218.00	239.00	146.00
R02SS141	206.00	157.00	155.00	147.00	139.00
R02SS142	724.00	200.00	183.00	179.00	173.00
R02SS144	1,700.00	415.00	574.00	1,080.00	74.90
R02SS145	316.00	171.00	203.00	494.00	144.00
R02SS146	58.50	175.00	221.00	163.00	420.00
R02SS147	328.00	210.00	224.00	205.00	157.00
R02SS148	4,140.00	4,980.00	3,540.00	3,980.00	2,330.00
R02SS149	673.00	2,090.00	10,800.00	410.00	1,300.00
R02SS150	3,880.00	343.00	359.00	206.00	375.00
R02SS151	81.00	238.00	240.00	105.00	207.00
R02SS207	159.00	63.70	51.60	31.20	338.00
R02SS267		1,840.00	1,310.00	1,080.00	375.00
R02SS268		156.00	1,200.00	807.00	192.00
R02SS269		475.00	300.00	1,110.00	326.00
R02SS271		55.00	6,750.00	3,970.00	2,680.00
R02SS272		996.00	475.00	342.00	209.00

Round	n	min	max	mean	S.D.
1	64	58.50	5,790.00	554.57	990.91
2	78	55.00	5,410.00	556.24	903.29
3	78	51.60	10,800.00	802.21	1,516.65
4	78	31.20	4,940.00	589.89	848.20
5	78	60.30	3,380.00	495.26	674.59

Notes:

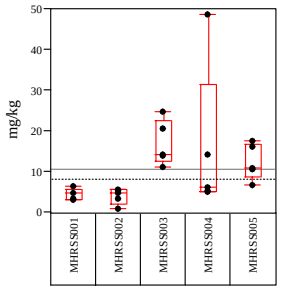
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

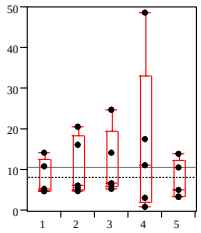
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MARSH REFERENCE AREA

ARSENIC

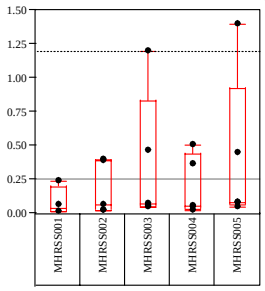


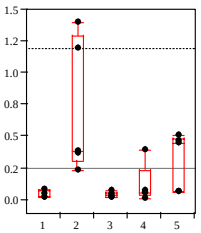


Location	Round 1	2	3	4	5
MHRSS001	5.10	4.90	6.60	3.40	3.50
MHRSS002	4.90	5.80	5.60	1.10	3.50
MHRSS003	14.50	20.80	24.90	11.50	14.30
MHRSS004	5.60	6.40	14.50	48.90	5.20
MHRSS005	11.00	16.30	6.90	17.80	10.90

Round	Summary Statistics n	min	max	mean	S.D.
1	5	4.90	14.50	8.22	4.32
2	5	4.90	20.80	10.84	7.24
3	5	5.60	24.90	11.70	8.19
4	5	1.10	48.90	16.54	19.27
5	5	3.50	14.30	7.48	4.88

CADMIUM





Location	Round 1	2	3	4	5
MHRSS001		0.24	0.02	0.02	0.07
MHRSS002	0.03	0.39	0.03	0.40	0.07
MHRSS003	0.05	1.20	0.08	0.06	0.47
MHRSS004	0.03	0.37	0.05	0.06	0.51
MHRSS005	0.09	1.40	0.05	0.08	0.45

Round	Summary Statistics n	min	max	mean	S.D.
1	4	0.03	0.09	0.05	0.03
2	5	0.24	1.40	0.72	0.54
3	5	0.02	0.08	0.04	0.02
4	5	0.02	0.40	0.12	0.16
5	5	0.07	0.51	0.31	0.23

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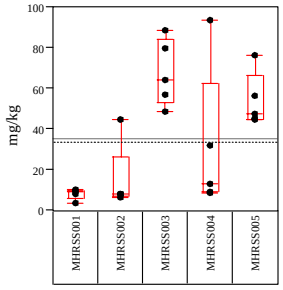

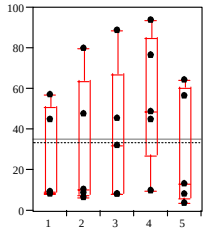

Location	Round 1	2	3	4	5
MHRSS001	9.70	10.60	8.10	9.90	3.85
MHRSS002	8.40	6.70	8.30	45.10	8.10
MHRSS003	57.40	80.10	88.70	48.90	64.40
MHRSS004	9.70	9.00	32.00	93.90	13.20
MHRSS005	44.90	47.90	45.40	76.40	56.80

Round	Summary Statistics n	min	max	mean	S.D.
1	5	8.40	57.40	26.02	23.37
2	5	6.70	80.10	30.86	32.35
3	5	8.10	88.70	36.50	33.26
4	5	9.90	93.90	54.84	32.17
5	5	3.85	64.40	29.27	28.92

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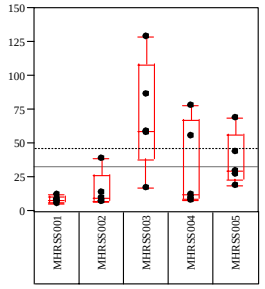
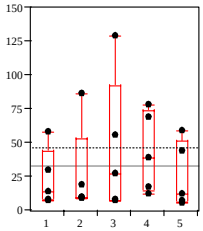
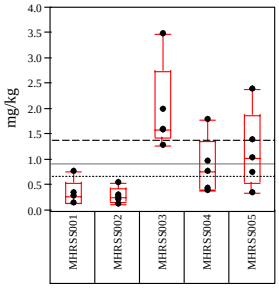


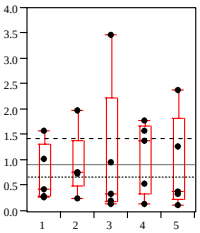


Location	Round 1	2	3	4	5
MHRSS001	7.50	9.50	8.60	12.10	6.00
MHRSS002	14.10	9.60	7.20	39.50	7.50
MHRSS003	58.10	87.00	129.00	17.80	58.80
MHRSS004	8.50	9.60	56.20	78.20	12.30
MHRSS005	29.90	19.40	27.80	69.40	44.30

Round	Summary Statistics n	min	max	mean	S.D.
1	5	7.50	58.10	23.62	21.26
2	5	9.50	87.00	27.02	33.80
3	5	7.20	129.00	45.76	50.57
4	5	12.10	78.20	43.40	29.74
5	5	6.00	58.80	25.78	24.19

SELENIUM

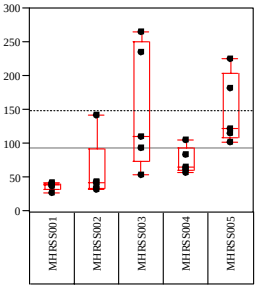


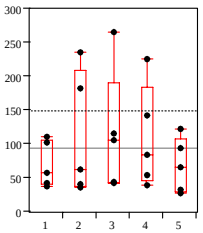


Location	Round 1	2	3	4	5
MHRSS001	0.29	0.77	0.17	0.17	0.35
MHRSS002	0.32	0.27	0.23	0.55	0.14
MHRSS003	1.60	2.00	3.50	1.60	1.30
MHRSS004	0.45	0.78	0.97	1.80	0.41
MHRSS005	1.05	0.75	0.36	1.40	2.40

Round	Summary Statistics n	min	max	mean	S.D.
1	5	0.29	1.60	0.74	0.57
2	5	0.27	2.00	0.91	0.64
3	5	0.17	3.50	1.04	1.41
4	5	0.17	1.80	1.10	0.71
5	5	0.14	2.40	0.92	0.94

ZINC





Location	Round 1	2	3	4	5
MHRSS001	38.50	40.90	43.20	39.70	27.80
MHRSS002	43.70	36.40	44.70	143.00	33.40
MHRSS003	111.00	237.00	267.00	54.30	95.00
MHRSS004	58.30	63.70	106.00	84.20	66.40
MHRSS005	104.00	184.00	116.00	226.00	123.00

Round	Summary Statistics n	min	max	mean	S.D.
1	5	38.50	111.00	71.10	34.10
2	5	36.40	237.00	112.40	92.08
3	5	43.20	267.00	115.38	91.22
4	5	39.70	226.00	109.44	76.25
5	5	27.80	123.00	69.12	40.51

Notes:

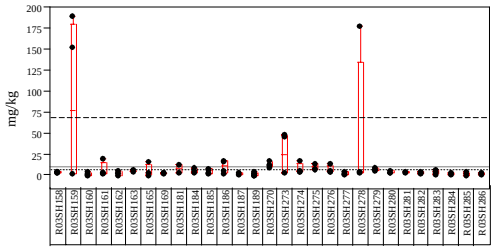
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

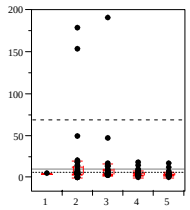
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK

ARSENIC

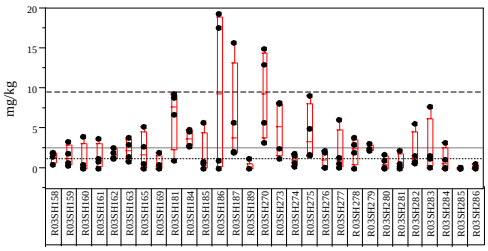


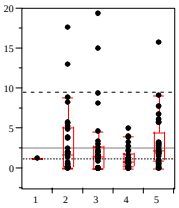


Location	Round 1	2	3	4	5
R03SH158		4.30	5.70	4.60	4.80
R03SH159		154.00	190.00	2.80	3.30
R03SH160		0.45	2.70	5.20	1.15
R03SH161		20.70	4.40	2.60	4.10
R03SH162		0.47	6.00	2.90	3.70
R03SH163		7.20	5.40	5.60	4.80
R03SH165		0.56	4.50	3.80	17.50
R03SH169		3.60	4.00	3.10	4.50
R03SH181		13.20	13.80	3.90	4.50
R03SH184		6.50	10.40	3.80	4.00
R03SH185		8.20	9.40	3.90	3.00
R03SH186		18.00	17.40	6.90	3.50
R03SH187		4.70	4.60	3.70	1.85
R03SH189	5.80	0.47	2.50	1.05	2.60
R03SH270		19.00	14.20	10.60	12.70
R03SH273		49.40	47.00	4.30	4.70
R03SH274		6.80	5.70	17.90	5.60
R03SH275		14.40	14.50	8.60	7.70
R03SH276		6.60	5.80	14.60	5.10
R03SH277		5.70	5.20	2.90	1.90
R03SH278		179.00	5.60	4.60	4.50
R03SH279		9.70	7.10	6.30	6.20
R03SH280		4.30	7.00	4.40	3.60
R03SH281		5.00	5.90	4.80	4.20
R03SH282		4.20	5.30	4.50	2.60
R03SH283		4.10	5.60	8.20	2.10
R03SH284		3.60	4.40	3.10	1.30
R03SH285		4.80	2.60	2.70	0.60
R03SH286		4.20	2.40	3.30	1.60

Round	Summary Statistics n	min	max	mean	S.D.
1	1	5.80	5.80	5.80	
2	29	0.45	179.00	19.42	41.97
3	29	2.40	190.00	14.45	34.79
4	29	1.05	17.90	5.33	3.66
5	29	0.60	17.50	4.40	3.43

CADMIUM





Location	Round 1	2	3	4	5
R03SH158		2.00	1.50	0.47	1.90
R03SH159		1.90	3.40	0.72	0.41
R03SH160		0.54	0.02	4.00	0.16
R03SH161		3.70	0.02	1.20	0.89
R03SH162		1.40	2.60	1.20	2.00
R03SH163		3.90	3.00	0.85	1.50
R03SH165		5.30	0.02	0.67	2.80
R03SH169		0.46	0.03	0.02	2.00
R03SH181		8.90	9.40	1.00	6.70
R03SH184		4.90	4.60	2.80	2.90
R03SH185		0.04	0.83	0.64	5.80
R03SH186		17.60	19.40	0.03	1.05
R03SH187		5.70	2.00	2.10	15.80
R03SH189	1.30	0.04	0.03	0.04	0.03
R03SH270		13.00	15.00	3.30	5.80
R03SH273		8.20	8.10	1.30	2.50
R03SH274		0.69	1.60	0.27	1.90
R03SH275		1.80	1.60	5.00	9.10
R03SH276		0.12	2.00	0.18	2.20
R03SH277		0.11	1.40	0.57	6.10
R03SH278		2.00	0.02	3.90	3.00
R03SH279		2.50	2.30	2.30	3.10
R03SH280		0.12	0.03	1.00	1.80
R03SH281		0.20	0.02	0.68	2.30
R03SH282		5.60	1.60	0.85	0.58
R03SH283		0.11	1.20	1.60	7.80
R03SH284		0.13	1.10	0.02	3.20
R03SH285		0.16	0.03	0.16	0.06
R03SH286		0.12	0.03	0.21	0.64

Round	Summary Statistics n	min	max	mean	S.D.
1	1	1.30	1.30	1.30	
2	29	0.04	17.60	3.15	4.26
3	29	0.02	19.40	2.86	4.61
4	29	0.02	5.00	1.28	1.34
5	29	0.03	15.80	3.24	3.40

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

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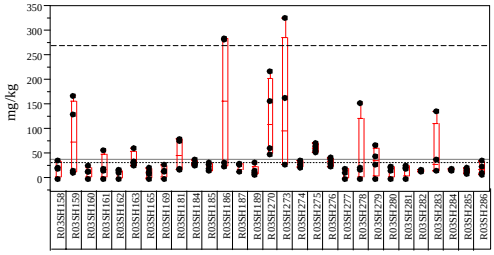
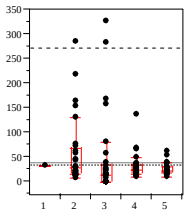
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK

COPPER

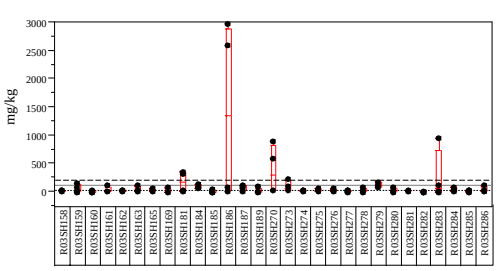


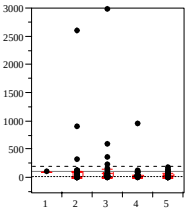


Location	Round 1	2	3	4	5
R03SH158		20.40	0.08	23.70	38.40
R03SH159		132.00	168.00	12.80	16.50
R03SH160		15.30	0.08	26.70	14.10
R03SH161		58.50	0.08	15.70	20.90
R03SH162		16.40	0.08	11.90	18.00
R03SH163		63.00	26.40	35.60	31.90
R03SH165		22.00	0.09	9.90	15.20
R03SH169		15.00	0.10	16.20	29.90
R03SH181		77.90	81.30	20.00	18.00
R03SH184		32.10	39.20	27.70	29.90
R03SH185		30.20	32.30	21.70	15.90
R03SH186		285.00	283.00	34.00	25.80
R03SH187		30.00	15.20	31.60	28.50
R03SH189	32.70	8.60	12.80	13.20	17.30
R03SH270		218.00	159.00	49.80	62.40
R03SH273		165.00	327.00	29.20	29.10
R03SH274		29.30	23.60	37.50	36.70
R03SH275		73.80	57.50	67.20	53.70
R03SH276		43.50	24.10	31.80	40.30
R03SH277		11.80	0.09	20.50	20.30
R03SH278		155.00	0.08	19.20	23.50
R03SH279		46.00	0.08	68.60	28.50
R03SH280		16.70	0.11	24.20	23.60
R03SH281		20.80	0.08	27.10	23.00
R03SH282		14.10	15.30	17.30	19.60
R03SH283		17.30	17.50	137.00	38.80
R03SH284		19.30	17.70	18.60	20.40
R03SH285		22.60	15.00	18.10	10.50
R03SH286		11.90	8.70	38.00	24.20

Round	Summary Statistics n	min	max	mean	S.D.
1	1	32.70	32.70	32.70	
2	29	8.60	285.00	57.64	68.60
3	29	0.08	327.00	45.67	83.65
4	29	9.90	137.00	31.20	24.97
5	29	10.50	62.40	26.72	11.73

LEAD





Location	Round 1	2	3	4	5
R03SH158		37.30	41.70	25.10	41.10
R03SH159		102.00	168.00	29.10	10.00
R03SH160		7.00	12.20	45.30	8.30
R03SH161		124.00	23.80	19.70	13.10
R03SH162		33.20	37.40	25.20	34.00
R03SH163		136.00	32.50	32.00	29.20
R03SH165		68.90	16.70	18.60	23.40
R03SH169		5.60	6.10	8.60	90.80
R03SH181		322.00	367.00	42.10	17.00
R03SH184		87.10	79.70	91.00	156.00
R03SH185		8.80	14.70	57.40	6.90
R03SH186		2,610.00	2,990.00	14.40	93.20
R03SH187		129.00	23.80	104.00	70.10
R03SH189	120.00	12.20	14.60	9.70	11.50
R03SH270		907.00	591.00	38.70	40.70
R03SH273		112.00	245.00	33.30	42.30
R03SH274		30.20	23.50	36.30	33.70
R03SH275		61.20	78.30	27.00	32.10
R03SH276		66.50	27.80	26.30	45.60
R03SH277		40.90	10.30	17.30	30.50
R03SH278		93.60	11.00	44.80	46.30
R03SH279		138.00	128.00	88.30	188.00
R03SH280		7.40	88.60	39.10	41.60
R03SH281		26.00	46.80	43.00	41.60
R03SH282		9.30	17.10	27.60	10.00
R03SH283		6.90	26.50	951.00	135.00
R03SH284		30.70	64.10	15.80	92.00
R03SH285		39.90	19.40	39.10	10.30
R03SH286		17.50	19.80	125.00	40.90

Round	Summary Statistics n	min	max	mean	S.D.
1	1	120.00	120.00	120.00	
2	29	5.60	2,610.00	181.73	496.83
3	29	6.10	2,990.00	180.19	554.96
4	29	8.60	951.00	71.54	171.49
5	29	6.90	188.00	49.49	45.65

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
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effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
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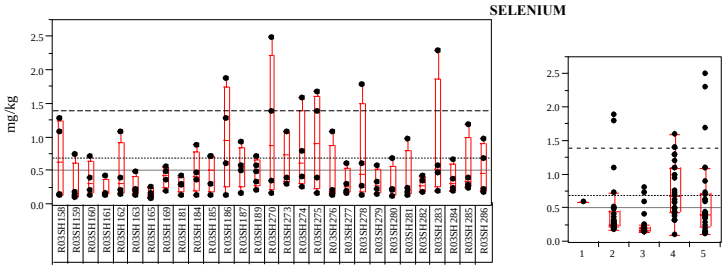
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK

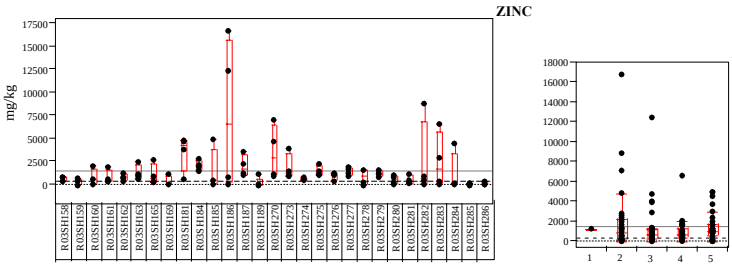
SELENIUM



Location	Round 1	2	3	4	5
R03SH158		1.10	0.18	1.30	0.15
R03SH159		0.20	0.16	0.77	0.12
R03SH160		0.23	0.16	0.74	0.42
R03SH161		0.19	0.17	0.44	0.16
R03SH162		0.23	0.17	0.41	1.10
R03SH163		0.22	0.16	0.50	0.24
R03SH165		0.28	0.19	0.11	0.12
R03SH169		0.50	0.22	0.58	0.38
R03SH181		0.30	0.16	0.32	0.44
R03SH184		0.49	0.16	0.38	0.90
R03SH185		0.74	0.16	0.32	0.73
R03SH186		1.90	0.16	1.30	0.62
R03SH187		0.52	0.19	0.95	0.60
R03SH189	0.60	0.24	0.74	0.51	0.35
R03SH270		0.36	0.19	1.40	2.50
R03SH273		0.33	0.41	1.10	1.10
R03SH274		0.28	0.81	1.60	0.44
R03SH275		0.42	0.19	1.40	1.70
R03SH276		0.23	0.17	1.10	0.16
R03SH277		0.22	0.19	0.32	0.62
R03SH278		1.80	0.16	0.63	0.29
R03SH279		0.24	0.17	0.59	0.36
R03SH280		0.24	0.23	0.70	0.14
R03SH281		0.26	0.16	1.00	0.21
R03SH282		0.20	0.21	0.45	0.37
R03SH283		0.21	0.59	0.49	2.30
R03SH284		0.26	0.21	0.69	0.40
R03SH285		0.31	0.27	1.20	0.41
R03SH286		0.25	0.20	0.99	0.70

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.60	0.60	0.60	
2	29	0.19	1.90	0.44	0.44
3	29	0.16	0.81	0.24	0.17
4	29	0.11	1.60	0.77	0.40
5	29	0.12	2.50	0.62	0.61

ZINC



Location	Round 1	2	3	4	5
R03SH158		922.00	900.00	432.00	873.00
R03SH159		480.00	739.00	532.00	31.50
R03SH160		638.00	673.00	2,090.00	91.70
R03SH161		2,000.00	431.00	710.00	412.00
R03SH162		497.00	1,310.00	928.00	787.00
R03SH163		2,590.00	1,200.00	706.00	1,050.00
R03SH165		2,780.00	355.00	475.00	1,040.00
R03SH169		62.30	89.80	89.40	1,270.00
R03SH181		4,800.00	3,900.00	720.00	4,920.00
R03SH184		2,180.00	2,870.00	1,960.00	1,610.00
R03SH185		119.00	542.00	554.00	4,990.00
R03SH186		16,800.00	12,500.00	165.00	910.00
R03SH187		2,330.00	1,310.00	1,110.00	3,680.00
R03SH189	1,250.00	61.90	63.30	40.60	51.30
R03SH270		7,120.00	4,770.00	1,040.00	1,190.00
R03SH273		1,610.00	4,030.00	985.00	1,060.00
R03SH274		532.00	703.00	645.00	873.00
R03SH275		1,120.00	1,210.00	1,550.00	2,370.00
R03SH276		1,310.00	1,260.00	444.00	1,070.00
R03SH277		1,340.00	982.00	1,810.00	1,950.00
R03SH278		279.00	42.90	1,670.00	1,670.00
R03SH279		1,220.00	933.00	1,650.00	1,280.00
R03SH280		102.00	378.00	935.00	1,060.00
R03SH281		187.00	299.00	585.00	1,240.00
R03SH282		8,870.00	949.00	564.00	161.00
R03SH283		70.20	474.00	6,620.00	3,040.00
R03SH284		190.00	250.00	82.40	4,530.00
R03SH285		173.00	79.10	180.00	48.00
R03SH286		65.80	69.40	460.00	158.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	1,250.00	1,250.00	1,250.00	
2	29	61.90	16,800.00	2,084.46	3,527.19
3	29	42.90	12,500.00	1,493.53	2,450.32
4	29	40.60	6,620.00	1,025.26	1,222.47
5	29	31.50	4,990.00	1,497.12	1,429.28

Notes:

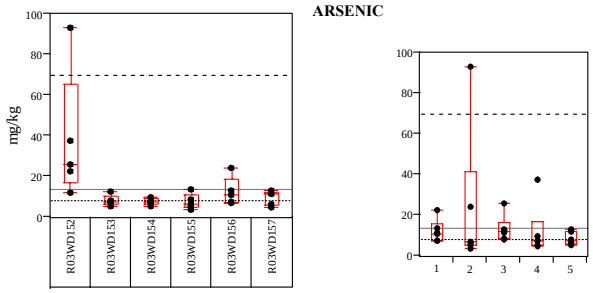
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 3 POND

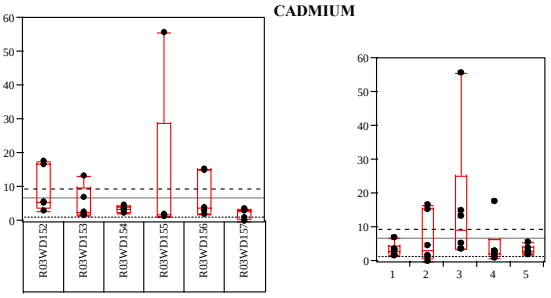
ARSENIC



Location	Round 1	2	3	4	5
R03WD152	22.90	93.30	26.10	37.90	12.00
R03WD153	7.80	5.70	12.70	7.80	8.30
R03WD154	7.60	7.40	8.60	10.10	5.80
R03WD155	13.80	4.10	8.90	5.80	6.40
R03WD156	10.90	24.20	13.30	7.70	7.00
R03WD157	11.40	6.70	11.80	5.10	13.10

Round	Summary Statistics n	min	max	mean	S.D.
1	6	7.60	22.90	12.40	5.65
2	6	4.10	93.30	23.57	34.95
3	6	8.60	26.10	13.57	6.44
4	6	5.10	37.90	12.40	12.61
5	6	5.80	13.10	8.77	3.07

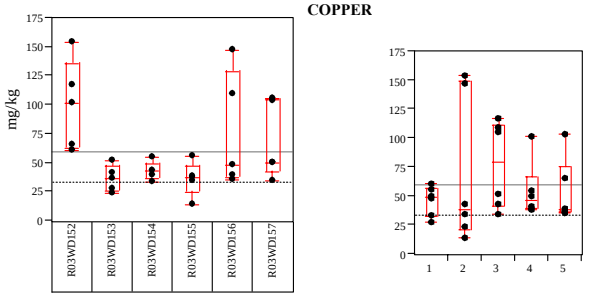
CADMIUM



Location	Round 1	2	3	4	5
R03WD152	2.90	16.70	5.20	17.60	5.60
R03WD153	6.90	1.70	13.40	2.10	2.80
R03WD154	3.80	4.80	3.70	2.90	2.50
R03WD155	1.70	1.30	55.70	2.00	1.90
R03WD156	1.90	15.30	15.10	3.10	3.90
R03WD157	3.20	0.14	3.70	1.10	3.00

Round	Summary Statistics n	min	max	mean	S.D.
1	6	1.70	6.90	3.40	1.89
2	6	0.14	16.70	6.66	7.41
3	6	3.70	55.70	16.13	20.01
4	6	1.10	17.60	4.80	6.31
5	6	1.90	5.60	3.28	1.31

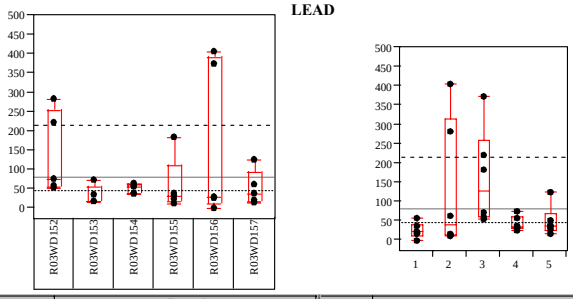
COPPER



Location	Round 1	2	3	4	5
R03WD152	61.10	155.00	118.00	102.00	66.10
R03WD153	28.10	24.30	52.70	41.80	37.00
R03WD154	34.50	43.40	43.50	55.50	40.20
R03WD155	56.40	14.50	35.20	38.60	37.50
R03WD156	49.00	148.00	110.00	39.80	36.00
R03WD157	50.40	34.60	106.00	50.80	104.00

Round	Summary Statistics n	min	max	mean	S.D.
1	6	28.10	61.10	46.58	12.77
2	6	14.50	155.00	69.97	63.94
3	6	35.20	118.00	77.57	37.60
4	6	38.60	102.00	54.75	24.09
5	6	36.00	104.00	53.47	27.28

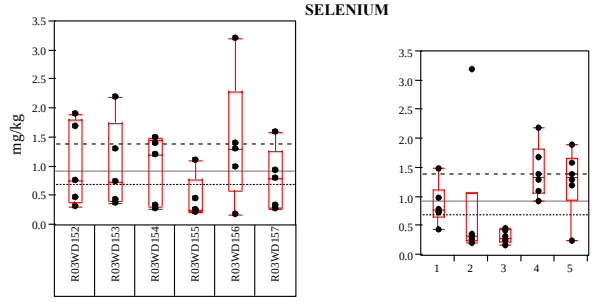
LEAD



Location	Round 1	2	3	4	5
R03WD152	59.00	285.00	223.00	77.60	53.70
R03WD153	17.50	18.40	75.40	36.00	18.80
R03WD154	38.00	65.40	57.80	59.20	38.90
R03WD155	25.60	12.40	184.00	33.90	37.80
R03WD156	0.23	408.00	376.00	28.40	31.00
R03WD157	22.80	15.30	63.10	38.50	126.00

Round	Summary Statistics n	min	max	mean	S.D.
1	6	0.23	59.00	27.19	19.86
2	6	12.40	408.00	134.08	170.19
3	6	57.80	376.00	163.22	125.00
4	6	28.40	77.60	45.60	18.89
5	6	18.80	126.00	51.03	38.44

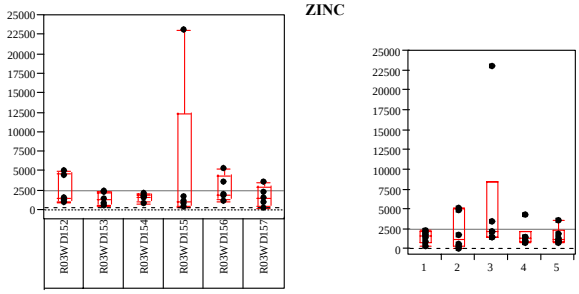
SELENIUM



Location	Round 1	2	3	4	5
R03WD152	0.75	0.32	0.48	1.70	1.90
R03WD153	0.74	0.37	0.43	2.20	1.30
R03WD154	1.50	0.34	0.28	1.40	1.20
R03WD155	0.45	0.21	0.26	1.10	0.25
R03WD156	1.00	3.20	0.18	1.30	1.40
R03WD157	0.80	0.27	0.33	0.94	1.60

Round	Summary Statistics n	min	max	mean	S.D.
1	6	0.45	1.50	0.87	0.36
2	6	0.21	3.20	0.78	1.18
3	6	0.18	0.48	0.32	0.11
4	6	0.94	2.20	1.44	0.45
5	6	0.25	1.90	1.28	0.56

ZINC



Location	Round 1	2	3	4	5
R03WD152	1,070.00	5,060.00	1,660.00	4,420.00	1,260.00
R03WD153	2,490.00	527.00	2,270.00	949.00	1,450.00
R03WD154	2,190.00	1,850.00	1,590.00	1,680.00	877.00
R03WD155	448.00	828.00	23,100.00	1,690.00	1,110.00
R03WD156	1,840.00	5,360.00	3,630.00	1,170.00	2,010.00
R03WD157	1,620.00	241.00	2,310.00	1,080.00	3,690.00

Round	Summary Statistics n	min	max	mean	S.D.
1	6	448.00	2,490.00	1,609.67	749.09
2	6	241.00	5,360.00	2,311.00	2,312.26
3	6	1,590.00	23,100.00	5,760.00	8,526.36
4	6	949.00	4,420.00	1,831.50	1,305.71
5	6	877.00	3,690.00	1,732.83	1,032.59

Notes:

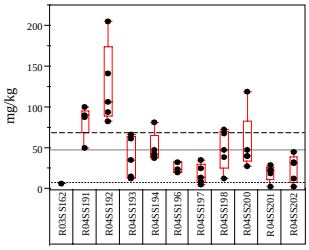
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

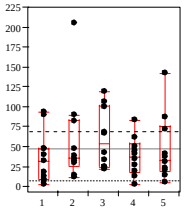
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
Y OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 3 AND 4 UPLAND

ARSENIC

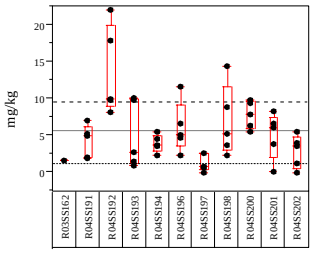


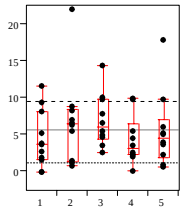


Location	Round 1	2	3	4	5
R03SS162	7.40				
R04SS191	90.80	90.70	101.00	51.60	88.20
R04SS192	94.60	206.00	108.00	84.30	143.00
R04SS193	13.60	36.10	67.30	63.10	16.00
R04SS194	48.30	83.10	43.30	41.90	38.20
R04SS196	33.90	33.40	25.40	21.00	21.70
R04SS197	10.20	15.40	26.00	35.70	6.80
R04SS198	49.20	39.40	69.30	13.60	73.20
R04SS200	41.00	48.40	120.00	28.40	41.80
R04SS201	19.90	30.60	23.60	4.00	24.10
R04SS202	3.50	13.40	34.00	46.30	31.90

Round	Summary Statistics n	min	max	mean	S.D.
1	11	3.50	94.60	37.49	31.73
2	10	13.40	206.00	59.65	57.40
3	10	23.60	120.00	61.79	37.01
4	10	4.00	84.30	38.99	23.97
5	10	6.80	143.00	48.49	41.70

CADMIUM

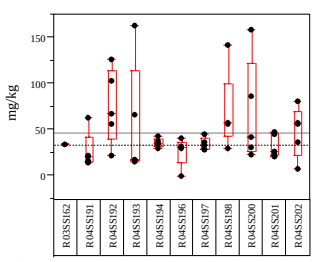


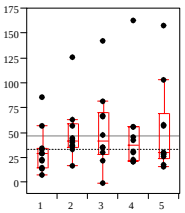


Location	Round 1	2	3	4	5
R03SS162	1.70				
R04SS191	2.00	7.10	5.00	2.10	5.30
R04SS192	8.20	22.10	9.80	10.00	17.90
R04SS193	2.80	1.50	10.20	9.80	0.92
R04SS194	3.70	5.50	3.60	4.60	2.30
R04SS196	11.70	6.70	4.70	2.40	5.20
R04SS197	0.02	0.81	2.60	2.70	0.72
R04SS198	5.30	8.90	14.40	2.40	3.80
R04SS200	9.50	6.40	7.90	5.50	9.90
R04SS201	3.90	8.40	6.60	0.13	6.10
R04SS202	0.03	1.20	5.60	3.60	4.00

Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.02	11.70	4.44	3.86
2	10	0.81	22.10	6.86	6.13
3	10	2.60	14.40	7.04	3.59
4	10	0.13	10.00	4.32	3.28
5	10	0.72	17.90	5.61	5.08

COPPER





Location	Round 1	2	3	4	5
R03SS162	35.00				
R04SS191	14.60	63.90	22.70	22.10	17.00
R04SS192	23.30	127.00	68.00	57.20	104.00
R04SS193	16.10	18.10	66.80	164.00	18.50
R04SS194	34.50	38.50	36.40	43.40	30.50
R04SS196	30.50	41.50	0.08	32.50	31.50
R04SS197	29.60	34.00	36.70	46.50	29.10
R04SS198	58.30	58.20	143.00	31.10	57.70
R04SS200	86.90	43.00	31.50	23.80	159.00
R04SS201	23.60	45.60	48.50	21.40	27.20
R04SS202	8.70	37.30	82.10	57.20	58.40

Round	Summary Statistics n	min	max	mean	S.D.
1	11	8.70	86.90	32.83	22.28
2	10	18.10	127.00	50.71	29.61
3	10	0.08	143.00	53.58	39.58
4	10	21.40	164.00	49.92	42.30
5	10	17.00	159.00	53.29	45.43

Notes:

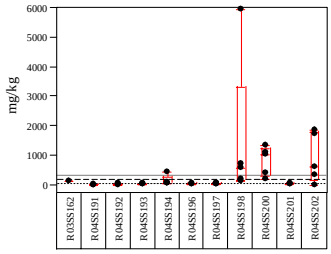
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

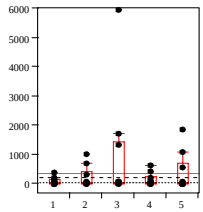
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 3 AND 4 UPLAND

LEAD

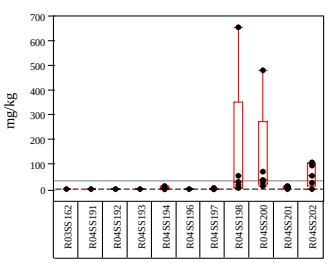


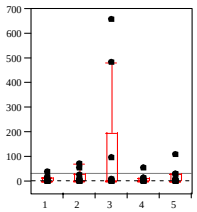


Location	Round 1	2	3	4	5
R03SS162	148.00				
R04SS191	7.00	29.10	11.20	10.60	6.80
R04SS192	9.20	37.90	14.60	45.30	18.00
R04SS193	12.90	13.30	62.00	24.40	11.00
R04SS194	72.70	88.50	70.80	450.00	71.80
R04SS196	22.90	20.80	72.50	30.00	19.40
R04SS197	70.20	44.70	47.00	65.00	43.00
R04SS198	213.00	707.00	5,980.00	126.00	577.00
R04SS200	400.00	1,030.00	1,360.00	213.00	1,100.00
R04SS201	43.60	48.30	37.30	32.80	26.50
R04SS202	6.70	333.00	1,740.00	631.00	1,880.00

Round	Summary Statistics n	min	max	mean	S.D.
1	11	6.70	400.00	91.47	121.74
2	10	13.30	1,030.00	235.26	354.84
3	10	11.20	5,980.00	939.54	1,880.55
4	10	10.60	631.00	162.81	212.34
5	10	6.80	1,880.00	375.35	639.19

SELENIUM

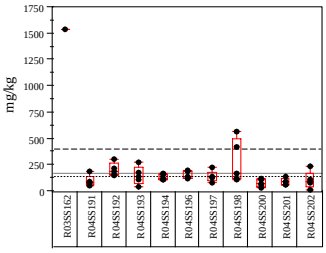


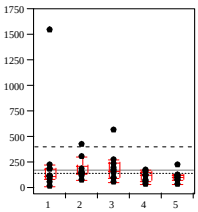


Location	Round 1	2	3	4	5
R03SS162	0.35				
R04SS191	0.36	0.24	0.16	1.10	0.34
R04SS192	0.37	0.20	0.16	1.80	0.42
R04SS193	0.36	0.19	0.16	1.90	0.25
R04SS194	0.37	6.60	5.10	13.80	0.70
R04SS196	0.37	0.22	0.17	1.70	0.36
R04SS197	0.36	0.19	0.16	3.30	0.25
R04SS198	16.40	55.10	657.00	4.40	29.70
R04SS200	36.00	71.70	482.00	12.80	30.20
R04SS201	12.70	6.00	7.50	0.81	6.60
R04SS202	0.39	23.30	97.90	53.60	109.00

Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.35	36.00	6.18	11.43
2	10	0.19	71.70	16.37	26.07
3	10	0.16	657.00	125.03	239.75
4	10	0.81	53.60	9.52	16.20
5	10	0.25	109.00	17.78	34.25

ZINC





Location	Round 1	2	3	4	5
R03SS162	1,550.00				
R04SS191	89.50	193.00	98.70	56.00	84.00
R04SS192	195.00	308.00	169.00	159.00	227.00
R04SS193	119.00	145.00	282.00	180.00	43.80
R04SS194	117.00	162.00	176.00	129.00	112.00
R04SS196	190.00	146.00	205.00	122.00	134.00
R04SS197	232.00	145.00	146.00	134.00	85.00
R04SS198	114.00	431.00	572.00	171.00	130.00
R04SS200	125.00	81.50	63.80	40.80	118.00
R04SS201	64.10	146.00	95.90	72.20	99.00
R04SS202	21.90	116.00	242.00	84.80	97.20

Round	Summary Statistics n	min	max	mean	S.D.
1	11	21.90	1,550.00	256.14	433.34
2	10	81.50	431.00	187.35	104.30
3	10	63.80	572.00	205.04	145.58
4	10	40.80	180.00	114.88	49.03
5	10	43.80	227.00	113.00	47.86

Notes:

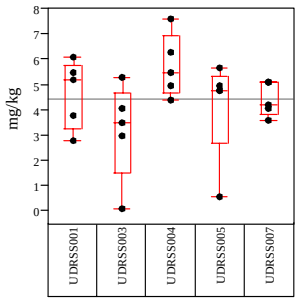
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

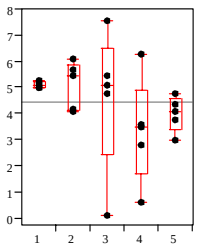
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

UPLANDS REFERENCE

ARSENIC

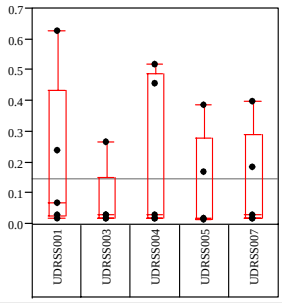


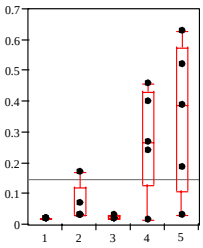


Location	Round 1	2	3	4	5
UDRSS001	5.20	6.10	5.50	2.80	3.80
UDRSS003	5.30	4.10	0.10	3.50	3.00
UDRSS004	5.00	5.50	7.60	6.30	4.40
UDRSS005	5.00	5.70	4.80	0.60	4.80
UDRSS007	5.10	4.20	5.10	3.60	4.10

Round	Summary Statistics n	min	max	mean	S.D.
1	5	5.00	5.30	5.12	0.13
2	5	4.10	6.10	5.12	0.91
3	5	0.10	7.60	4.62	2.75
4	5	0.60	6.30	3.36	2.04
5	5	3.00	4.80	4.02	0.68

CADMIUM

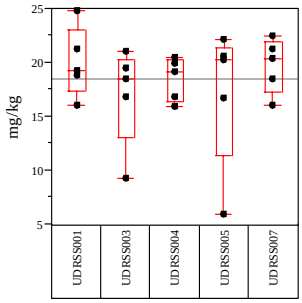


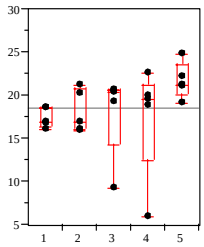


Location	Round 1	2	3	4	5
UDRSS001	0.02	0.07	0.03	0.24	0.63
UDRSS003	0.02	0.03	0.02	0.27	0.03
UDRSS004	0.02	0.03	0.02	0.46	0.52
UDRSS005	0.02	0.17	0.02	0.02	0.39
UDRSS007	0.02	0.03	0.02	0.40	0.19

Round	Summary Statistics n	min	max	mean	S.D.
1	5	0.02	0.02	0.02	0.00
2	5	0.03	0.17	0.07	0.06
3	5	0.02	0.03	0.02	0.01
4	5	0.02	0.46	0.28	0.17
5	5	0.03	0.63	0.35	0.24

COPPER

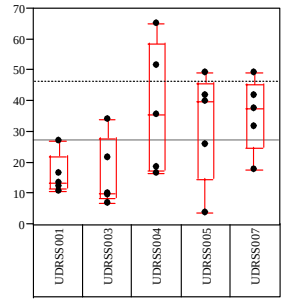


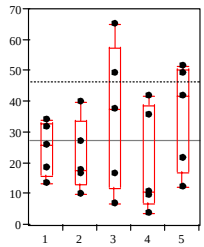


Location	Round 1	2	3	4	5
UDRSS001	16.10	21.30	19.30	18.90	24.90
UDRSS003	18.60	16.90	9.30	19.60	21.10
UDRSS004	16.90	16.00	20.60	20.00	19.20
UDRSS005	16.80	20.30	20.70	6.00	22.20
UDRSS007	18.60	16.10	20.40	22.60	21.30

Round	Summary Statistics n	min	max	mean	S.D.
1	5	16.10	18.60	17.40	1.14
2	5	16.00	21.30	18.12	2.50
3	5	9.30	20.70	18.06	4.93
4	5	6.00	22.60	17.42	6.54
5	5	19.20	24.90	21.74	2.08

LEAD

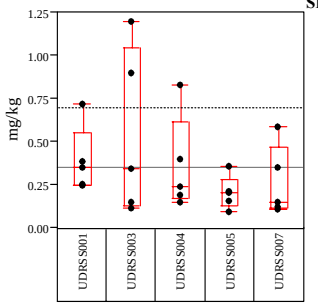


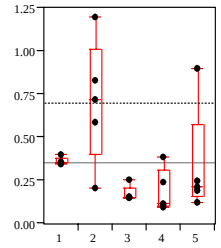


Location	Round 1	2	3	4	5
UDRSS001	13.50	27.40	16.90	10.90	12.50
UDRSS003	34.10	10.00	6.90	9.90	21.60
UDRSS004	18.50	16.80	65.50	35.90	51.60
UDRSS005	26.00	40.20	49.50	3.80	42.00
UDRSS007	31.90	17.90	37.70	42.00	49.30

Round	Summary Statistics n	min	max	mean	S.D.
1	5	13.50	34.10	24.80	8.74
2	5	10.00	40.20	22.46	11.70
3	5	6.90	65.50	35.30	23.79
4	5	3.80	42.00	20.50	17.20
5	5	12.50	51.60	35.40	17.42

SELENIUM

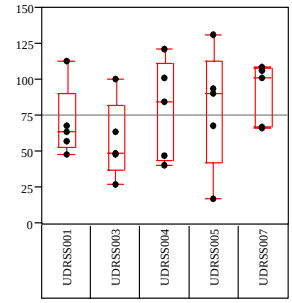


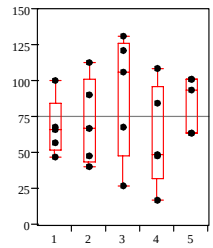


Location	Round 1	2	3	4	5
UDRSS001	0.36	0.72	0.26	0.39	0.25
UDRSS003	0.35	1.20	0.16	0.12	0.90
UDRSS004	0.41	0.83	0.16	0.24	0.20
UDRSS005	0.36	0.21	0.16	0.10	0.22
UDRSS007	0.36	0.59	0.16	0.11	0.13

Round	Summary Statistics n	min	max	mean	S.D.
1	5	0.35	0.41	0.37	0.02
2	5	0.21	1.20	0.71	0.36
3	5	0.16	0.26	0.18	0.04
4	5	0.10	0.39	0.19	0.13
5	5	0.13	0.90	0.34	0.32

ZINC





Location	Round 1	2	3	4	5
UDRSS001	57.70	113.00	68.50	48.40	63.80
UDRSS003	101.00	48.00	27.50	49.00	64.10
UDRSS004	47.30	41.00	122.00	84.60	102.00
UDRSS005	68.30	90.80	132.00	17.40	94.40
UDRSS007	66.40	67.90	107.00	109.00	102.00

Round	Summary Statistics n	min	max	mean	S.D.
1	5	47.30	101.00	68.14	20.16
2	5	41.00	113.00	72.14	29.95
3	5	27.50	132.00	91.40	43.12
4	5	17.40	109.00	61.68	35.58
5	5	63.80	102.00	85.26	19.70

Notes:

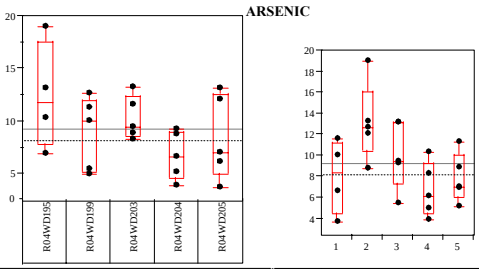
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 4 WETLAND

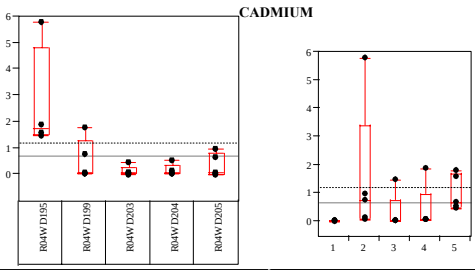
ARSENIC



Location	Round 1	2	3	4	5
R04WD195		19.00	13.20	10.40	7.00
R04WD199	10.10	12.70	5.50	5.00	11.30
R04WD203	11.60	13.30	9.50	8.30	8.90
R04WD204	6.70	8.80	9.30	4.00	5.20
R04WD205	3.80	12.10	13.20	6.20	7.10

Round	Summary Statistics n	min	max	mean	S.D.
1	4	3.80	11.60	8.05	3.50
2	5	8.80	19.00	13.18	3.69
3	5	5.50	13.20	10.14	3.22
4	5	4.00	10.40	6.78	2.58
5	5	5.20	11.30	7.90	2.31

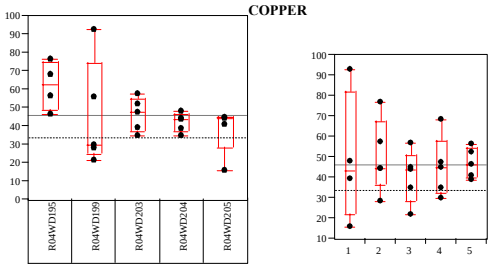
CADMIUM



Location	Round 1	2	3	4	5
R04WD195		5.80	1.50	1.90	1.60
R04WD199	0.06	0.78	0.04	0.07	1.80
R04WD203	0.04	0.08	0.03	0.07	0.46
R04WD204	0.04	0.16	0.05	0.08	0.55
R04WD205	0.02	0.98	0.03	0.09	0.68

Round	Summary Statistics n	min	max	mean	S.D.
1	4	0.02	0.06	0.04	0.01
2	5	0.08	5.80	1.56	2.40
3	5	0.03	1.50	0.33	0.65
4	5	0.07	1.90	0.44	0.82
5	5	0.46	1.80	1.02	0.63

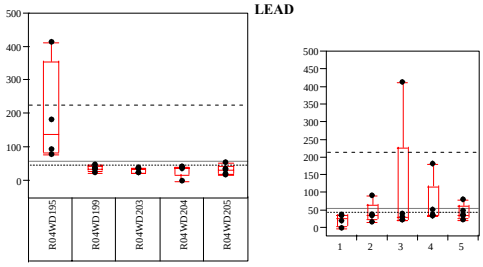
COPPER



Location	Round 1	2	3	4	5
R04WD195		76.90	56.80	68.60	46.40
R04WD199	93.00	28.40	21.80	30.00	56.30
R04WD203	39.30	57.70	34.80	47.60	52.40
R04WD204	48.20	44.60	44.10	35.00	39.10
R04WD205	16.00	44.30	44.80	45.20	41.10

Round	Summary Statistics n	min	max	mean	S.D.
1	4	16.00	93.00	49.13	32.25
2	5	28.40	76.90	50.38	18.10
3	5	21.80	56.80	40.46	13.03
4	5	30.00	68.60	45.28	14.90
5	5	39.10	56.30	47.06	7.30

LEAD



Location	Round 1	2	3	4	5
R04WD195		93.00	413.00	183.00	79.70
R04WD199	39.20	33.90	23.60	36.30	48.00
R04WD203	35.50	38.60	23.60	35.10	22.30
R04WD204	0.32	36.40	41.10	37.10	37.10
R04WD205	20.90	17.60	33.30	53.50	34.90

Round	Summary Statistics n	min	max	mean	S.D.
1	4	0.32	39.20	23.98	17.64
2	5	17.60	93.00	43.90	28.67
3	5	23.60	413.00	106.92	171.26
4	5	35.10	183.00	69.00	64.17
5	5	22.30	79.70	44.40	21.74

Notes:

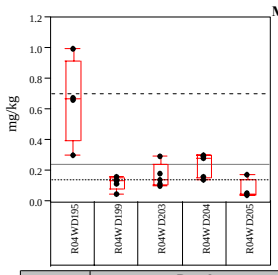
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

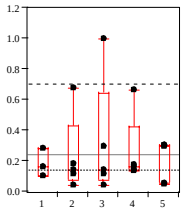
effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G1 (Continued)
SUMMARY OF SOIL AND SEDIMENT METAL CONCENTRATIONS IN EACH HABITAT AREA
DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 4 WETLAND

MERCURY

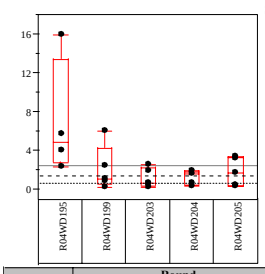


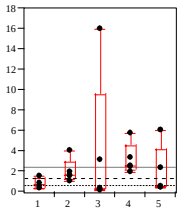


Location	Round 1	2	3	4	5
R04WD195		0.68	1.00	0.67	0.31
R04WD199	0.17	0.12	0.15	0.14	0.06
R04WD203	0.11	0.19	0.12	0.15	0.30
R04WD204	0.29	0.15	0.30	0.17	0.31
R04WD205		0.05	0.05	0.18	0.06

Round	Summary Statistics n	min	max	mean	S.D.
1	3	0.11	0.29	0.19	0.09
2	5	0.05	0.68	0.24	0.25
3	5	0.05	1.00	0.32	0.39
4	5	0.14	0.67	0.26	0.23
5	5	0.06	0.31	0.21	0.14

SELENIUM

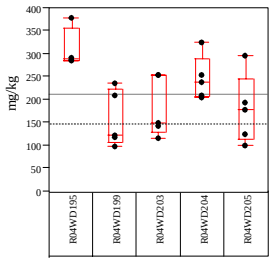


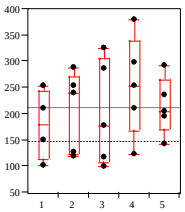


Location	Round 1	2	3	4	5
R04WD195		4.10	16.00	5.80	2.40
R04WD199	0.90	1.10	0.32	2.50	6.10
R04WD203	0.65	2.00	0.24	2.60	0.55
R04WD204	1.60	1.60	0.41	2.00	0.65
R04WD205	0.37	1.70	3.20	3.40	0.48

Round	Summary Statistics n	min	max	mean	S.D.
1	4	0.37	1.60	0.88	0.53
2	5	1.10	4.10	2.10	1.16
3	5	0.24	16.00	4.03	6.81
4	5	2.00	5.80	3.26	1.51
5	5	0.48	6.10	2.04	2.41

ZINC





Location	Round 1	2	3	4	5
R04WD195		289.00	287.00	380.00	293.00
R04WD199	211.00	120.00	100.00	124.00	237.00
R04WD203	151.00	255.00	118.00	255.00	144.00
R04WD204	255.00	241.00	327.00	212.00	206.00
R04WD205	103.00	127.00	179.00	298.00	196.00

Round	Summary Statistics n	min	max	mean	S.D.
1	4	103.00	255.00	180.00	66.72
2	5	120.00	289.00	206.40	77.70
3	5	100.00	327.00	202.20	101.04
4	5	124.00	380.00	253.80	95.49
5	5	144.00	293.00	215.20	54.89

Notes:

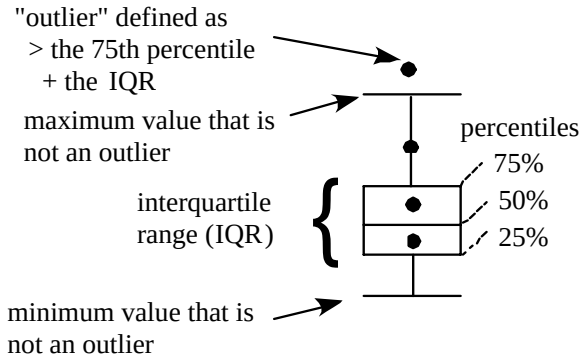
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

effects-range low (ER-L)
effects-range median (ER-M)
grand mean for locations or rounds

ATTACHMENT G2

SUMMARY OF MEAN EFFECTS-RANGE MEDIAN QUOTIENT VALUES FOR INDIVIDUAL HABITATS CALCULATED USING SIX METALS AND MONITORING DATA FROM YEARS 1 THROUGH 5

Key for
Outlier Box Plots



shaded line through center of each plot is the grand mean across all locations

ATTACHMENT G2

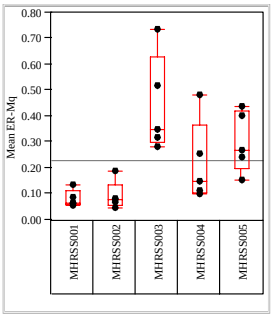
SUMMARY OF MEAN EFFECTS RANGE-MEDIAN QUOTIENT VALUES FOR INDIVIDUAL HABITATS CALCULATED USING SIX METALS AND MONITORING DATA FROM YEARS ONE THROUGH FIVE

FIVE-YEAR PERIODIC REVIEW ASSESSMENT

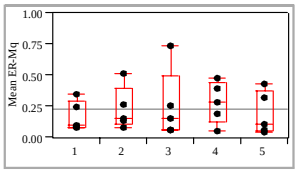
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT

CONCORD, CALIFORNIA

MARSH REFERENCE



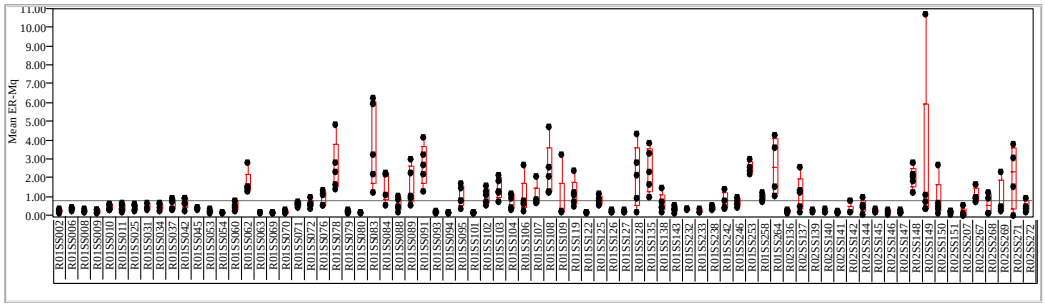
MARSH REFERENCE



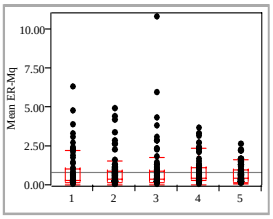
Location	Round 1	2	3	4	5
MHRSS001	0.09	0.14	0.06	0.06	0.07
MHRSS002	0.08	0.08	0.07	0.19	0.05
MHRSS003	0.35	0.52	0.74	0.28	0.32
MHRSS004	0.10	0.15	0.26	0.48	0.11
MHRSS005	0.25	0.27	0.16	0.40	0.44

Round	Summary Statistics n	min	max	mean	S.D.
1	5	0.08	0.35	0.17	0.12
2	5	0.08	0.52	0.23	0.18
3	5	0.06	0.74	0.26	0.28
4	5	0.06	0.48	0.28	0.17
5	5	0.05	0.44	0.20	0.17

MARSH SURFACE



MARSH SURFACE



Location	Round 1	2	3	4	5
R01SS002	0.29	0.21	0.30	0.40	0.34
R01SS006	0.39	0.33	0.47	0.40	0.48
R01SS008	0.26	0.24	0.24	0.42	0.23
R01SS009	0.39	0.27	0.23	0.39	0.20
R01SS010	0.38	0.61	0.38	0.45	0.70
R01SS011	0.62	0.72	0.27	0.41	0.37
R01SS025	0.61	0.31	0.38	0.65	0.60
R01SS031	0.71	0.71	0.37	0.39	0.50
R01SS034		0.67	0.30	0.71	0.46
R01SS037	0.35	0.45	0.79	1.00	0.83
R01SS042	0.70	0.97	0.30	0.67	0.97
R01SS045	0.51	0.43	0.40	0.48	0.39
R01SS053	0.24	0.23	0.20	0.34	0.40
R01SS054	0.23	0.23	0.22	0.23	0.21
R01SS060	0.61	0.30	0.88	0.84	0.48
R01SS062	1.44	1.58	2.87	1.37	1.61
R01SS063	0.25	0.26	0.21	0.22	0.23
R01SS069	0.23	0.22	0.19	0.21	0.21
R01SS070	0.21	0.21	0.21	0.36	0.30
R01SS071	0.63	0.52	0.81	0.72	0.66
R01SS072	0.65	1.06	0.40	0.66	0.64
R01SS076	1.42	0.62	1.18	1.21	0.64
R01SS078	2.38	4.89	2.86	1.69	1.48
R01SS079	0.25	0.28	0.20	0.34	0.32
R01SS080	0.21	0.19	0.22	0.25	0.23
R01SS083	6.27	1.31	5.96	3.29	2.25

Location	Round 1	2	3	4	5
R01SS084	2.26	0.63	2.35	2.28	1.16
R01SS088	1.08	0.26	0.94	0.53	0.47
R01SS089	3.06	1.12	0.61	2.32	0.96
R01SS091	3.29	4.20	2.28	2.73	1.32
R01SS093	0.29	0.19	0.20	0.23	0.27
R01SS094	0.24	0.24	0.20	0.23	0.20
R01SS095	1.75	0.86	0.41	1.51	0.88
R01SS101	0.23	0.23	0.20	0.23	0.18
R01SS102	0.64	0.78	1.33	1.16	1.66
R01SS103	1.89	1.32	1.31	0.78	2.22
R01SS104	0.48	1.19	0.34	1.21	0.95
R01SS106	0.30	0.84	0.75	2.72	0.65
R01SS107	2.15	0.85	0.72	0.74	0.94
R01SS108	4.76	2.61	1.31	2.12	1.32
R01SS109	0.26	0.27	0.23	3.27	0.31
R01SS119	2.45	0.77	1.14	1.26	0.56
R01SS122	0.24	0.25	0.23	0.20	0.26
R01SS125	0.66	0.64	0.96	0.84	1.23
R01SS126	0.25	0.23	0.22	0.37	0.25
R01SS127	0.26	0.25	0.24	0.34	0.26
R01SS128	0.21	4.38	2.89	0.97	2.21
R01SS135	3.88	3.34	2.36	1.03	1.69
R01SS138	0.51	0.77	0.49	0.27	1.54
R01SS143	0.38	0.18	0.42	0.44	0.63
R01SS232		0.45	0.39	0.35	0.45
R01SS233		0.27	0.24	0.44	0.22

Location	Round 1	2	3	4	5
R01SS238		0.58	0.41	0.54	0.36
R01SS242		0.48	0.45	0.88	1.46
R01SS246		1.04	0.47	0.87	0.70
R01SS253		2.26	3.05	2.43	2.62
R01SS258		0.81	0.91	1.09	1.29
R01SS264		1.13	4.36	3.67	1.57
R02SS136	0.24	0.32	0.20	0.36	0.31
R02SS137	0.27	2.64	1.43	1.26	0.55
R02SS139	0.25	0.23	0.26	0.36	0.37
R02SS140	0.25	0.22	0.24	0.42	0.24
R02SS141	0.27	0.20	0.18	0.32	0.22
R02SS142	0.87	0.22	0.24	0.26	0.21
R02SS144	1.06	0.48	0.64	0.64	0.13
R02SS145	0.29	0.22	0.25	0.44	0.24
R02SS146	0.10	0.22	0.24	0.35	0.34
R02SS147	0.35	0.21	0.26	0.26	0.19
R02SS148	2.26	2.85	1.87	2.11	1.31
R02SS149	0.42	1.18	10.76	0.43	0.79
R02SS150	2.72	0.40	0.54	0.19	0.72
R02SS151	0.12	0.28	0.25	0.24	0.33
R02SS207	0.19	0.11	0.10	0.05	0.62
R02SS267		1.01	0.96	0.78	1.69
R02SS268		0.21	1.00	1.28	0.19
R02SS269		0.42	0.28	2.41	0.58
R02SS271		0.08	3.85	3.14	1.59
R02SS272		0.99	0.58	0.45	0.25

Round	Summary Statistics n	min	max	mean	S.D.
1	64	0.10	6.27	0.96	1.22
2	78	0.08	4.89	0.82	0.99
3	78	0.10	10.76	0.99	1.55
4	78	0.05	3.67	0.92	0.86
5	78	0.13	2.62	0.74	0.59

Notes:

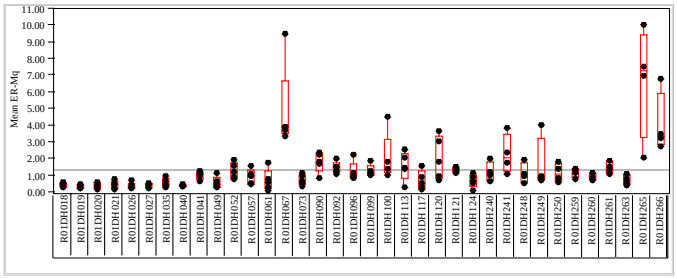
rounds individual monitoring years
n number of locations
S.D. standard deviation of arithmetic mean
min minimum concentration
max maximum concentration

grand mean for locations or rounds

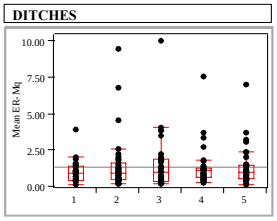
ATTACHMENT G2 (Continued)

SUMMARY OF MEAN EFFECTS RANGE-MEDIAN QUOTIENT VALUES FOR INDIVIDUAL HABITATS CALCULATED USING SIX METALS AND MONITORING DATA FROM YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

DITCHES



DITCHES

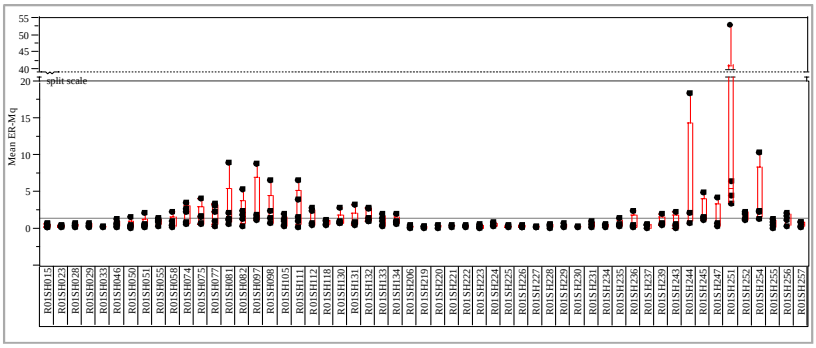


Location	Round 1	2	3	4	5
R01DH018	0.61	0.65	0.34	0.55	0.52
R01DH019	0.48	0.57	0.33	0.46	0.28
R01DH020	0.49	0.27	0.37	0.68	0.68
R01DH021	0.55	0.31	0.27	0.88	0.55
R01DH026	0.77	0.31	0.29	0.35	0.47
R01DH027	0.50	0.28	0.53	0.58	0.63
R01DH035	0.50	0.58	0.37	0.74	1.05
R01DH040	0.46	0.52	0.41	0.43	0.47
R01DH041	1.14	1.34	0.73	1.23	1.03
R01DH049	1.22	0.71	0.44	0.35	0.53
R01DH052	1.64	0.86	2.00	1.30	0.99
R01DH057	1.67	1.03	0.52	1.17	0.63
R01DH061	0.20	0.40	1.80	0.83	0.65
R01DH067	3.99	9.51	3.95	3.43	3.79
R01DH073	1.01	0.60	0.46	1.22	0.76
R01DH090	0.91	2.32	1.75	1.90	2.46
R01DH092	1.57	1.17	2.07	1.34	1.56
R01DH096	1.05	1.23	2.33	1.05	0.94

Location	Round 1	2	3	4	5
R01DH099	1.93	1.36	1.15	1.23	1.08
R01DH100	1.12	4.60	1.90	1.45	1.47
R01DH113	2.13	2.64	0.35	1.45	1.54
R01DH117	0.41	1.68	0.26	0.96	0.60
R01DH120	0.77	1.92	1.03	3.75	3.13
R01DH121	1.39	1.56	1.35	1.21	1.52
R01DH124	1.21	0.97	0.62	0.76	0.19
R01DH240		0.72	1.09	1.26	2.08
R01DH241		1.15	3.93	1.83	2.45
R01DH248		1.03	2.04	0.58	1.15
R01DH249		0.81	4.10	1.01	0.93
R01DH250		0.65	1.89	0.90	1.46
R01DH259		1.42	1.45	1.22	0.87
R01DH260		0.92	0.80	1.20	1.25
R01DH261		1.98	1.43	1.17	1.60
R01DH263		0.48	0.86	0.62	1.19
R01DH265		2.12	10.08	7.60	7.05
R01DH266		6.83	3.55	2.81	3.28

Round	Summary Statistics n	min	max	mean	S.D.
1	25	0.20	3.99	1.11	0.79
2	36	0.27	9.51	1.54	1.86
3	36	0.26	10.08	1.58	1.83
4	36	0.35	7.60	1.38	1.31
5	36	0.19	7.05	1.41	1.29

SLOUGH



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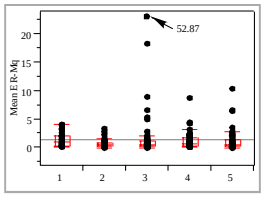


Location	Round 1	2	3	4	5
R01SH015	0.28	0.38	0.66	0.82	0.33
R01SH023	0.35		0.61	0.35	0.26
R01SH028	0.56	0.39	0.82	0.51	0.31
R01SH029	0.49	0.30	0.81	0.78	0.38
R01SH033	0.40	0.46	0.41	0.32	0.23
R01SH046	0.42	0.74	1.43	0.87	0.34
R01SH050	1.66	0.55	0.30	0.39	0.20
R01SH051	2.24	0.43	0.27	0.50	0.65
R01SH055	1.00	0.44	1.11	1.52	1.23
R01SH058	0.50	0.23	1.17	2.30	0.59
R01SH074	2.71	0.74	0.95	2.37	3.58
R01SH075	4.21	0.66	1.62	1.80	0.78
R01SH077	3.54	1.05	2.30	3.23	0.46
R01SH081	2.22	0.65	8.99	1.36	1.24
R01SH082	1.97	1.35	5.40	0.40	2.47
R01SH097	1.22		1.88	8.84	1.49
R01SH098	0.81	0.83	6.68	2.55	1.46
R01SH105	1.44	0.49	0.46	2.03	1.06
R01SH111	3.97	1.05	0.26	1.70	6.65

Location	Round 1	2	3	4	5
R01SH112	0.85	0.52	0.55	2.46	2.93
R01SH118	1.23	1.23	0.71	1.17	0.59
R01SH130	0.77	2.85	0.86	1.10	0.99
R01SH131	3.35	0.87	1.03	0.87	0.53
R01SH132	1.57	1.16	2.88	1.06	2.82
R01SH133	2.04	0.50	0.47	1.14	1.56
R01SH134	2.14	0.97	0.73	1.08	1.01
R01SH206	0.25	0.23	0.19	0.25	0.60
R01SH219		0.14	0.42	0.22	0.39
R01SH220		0.60	0.61	0.51	0.13
R01SH221		0.50	0.57	0.59	0.35
R01SH222		0.30	0.26	0.54	0.38
R01SH223		0.37	0.15	0.22	0.69
R01SH224		0.59	0.42	0.94	0.62
R01SH225		0.25	0.22	0.49	0.40
R01SH226		0.22	0.46	0.32	0.53
R01SH227		0.21	0.36	0.39	0.32
R01SH228		0.35	0.68	0.62	0.18

Location	Round 1	2	3	4	5
R01SH229		0.39	0.81	0.30	0.24
R01SH230		0.34	0.28	0.30	0.37
R01SH231		1.11	0.75	0.29	0.24
R01SH234		0.69	0.58	0.31	0.29
R01SH235		0.52	1.52	0.35	0.64
R01SH236		0.26	0.56	0.41	2.47
R01SH237		0.53	0.10	0.75	0.54
R01SH239		0.64	0.81	0.50	2.02
R01SH243		0.36	0.68	2.33	0.13
R01SH244		0.84	18.50	2.18	2.21
R01SH245		1.71	5.05	1.57	1.20
R01SH247		0.48	0.39	4.37	0.82
R01SH251		3.47	52.87	4.61	6.51
R01SH252		1.18	1.37	2.41	2.14
R01SH254		2.47	1.39	2.30	10.45
R01SH255		1.01	0.18	1.39	0.50
R01SH256		1.28	0.40	1.83	2.21
R01SH257		0.34	0.98	0.39	0.91

Round	Summary Statistics n	min	max	mean	S.D.
1	27	0.25	4.21	1.56	1.17
2	53	0.14	3.47	0.76	0.65
3	55	0.10	52.87	2.45	7.49
4	55	0.22	8.84	1.33	1.45
5	55	0.13	10.45	1.32	1.84

Notes:

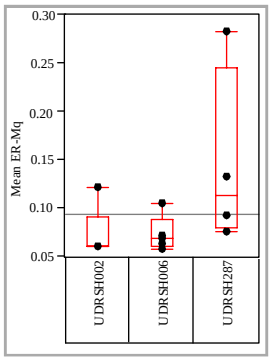
rounds individual monitoring years
n number of locations
S.D. standard deviation of arithmetic mean
min minimum concentration
max maximum concentration

grand mean for locations or rounds

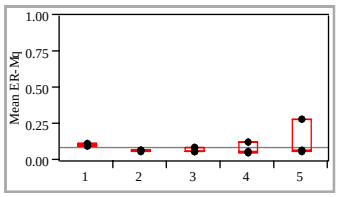
ATTACHMENT G2 (Continued)

MMARY OF MEAN EFFECTS RANGE-MEDIAN QUOTIENT VALUES FOR INDIVIDUAL HABITATS CALCULATED USIN SIX METALS AND MONITORING DATA FROM YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

CREEK REFERENCE



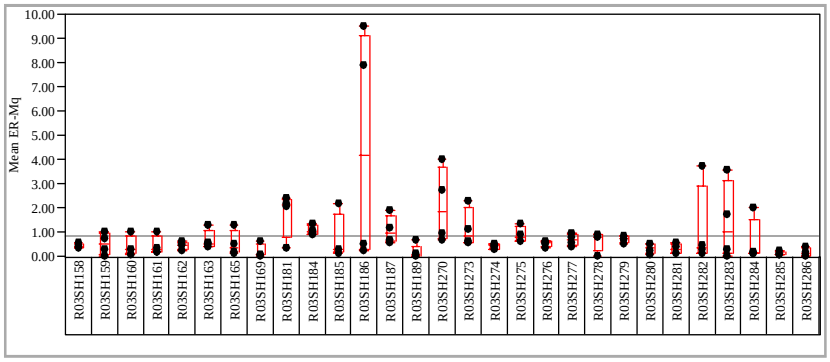
CREEK REFERENCE



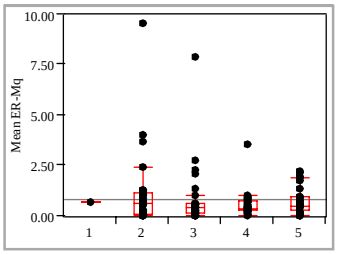
Location	Round 1	2	3	4	5
UDRSH002	0.12	0.06	0.06	0.06	0.06
UDRSH006	0.11	0.07	0.06	0.06	0.07
UDRSH287		0.08	0.09	0.13	0.28

Round	Summary Statistics n	min	max	mean	S.D.
1	2	0.11	0.12	0.11	0.01
2	3	0.06	0.08	0.07	0.01
3	3	0.06	0.09	0.07	0.02
4	3	0.06	0.13	0.08	0.04
5	3	0.06	0.28	0.14	0.13

NICHOLS CREEK



NICHOLS CREEK



Location	Round 1	2	3	4	5
R03SH158		0.59	0.46	0.38	0.47
R03SH159		0.78	1.06	0.36	0.06
R03SH160		0.31	0.31	1.07	0.11
R03SH161		1.08	0.22	0.39	0.23
R03SH162		0.29	0.64	0.48	0.53
R03SH163		1.31	0.61	0.42	0.53
R03SH165		1.32	0.19	0.25	0.55
R03SH169		0.11	0.08	0.13	0.69
R03SH181		2.47	2.13	0.40	2.20
R03SH184		1.13	1.38	0.99	0.96
R03SH185		0.18	0.31	0.34	2.24
R03SH186		9.58	7.94	0.27	0.56
R03SH187		1.24	0.63	0.71	1.92
R03SH189	0.73	0.07	0.14	0.10	0.09
R03SH270		4.04	2.81	0.73	0.98

Location	Round 1	2	3	4	5
R03SH273		1.14	2.33	0.61	0.67
R03SH274		0.32	0.46	0.55	0.50
R03SH275		0.66	0.67	0.97	1.40
R03SH276		0.66	0.62	0.39	0.56
R03SH277		0.62	0.47	0.82	1.01
R03SH278		0.96	0.06	0.88	0.83
R03SH279		0.72	0.55	0.91	0.79
R03SH280		0.10	0.27	0.54	0.53
R03SH281		0.15	0.19	0.43	0.62
R03SH282		3.75	0.47	0.34	0.14
R03SH283		0.08	0.33	3.61	1.78
R03SH284		0.15	0.22	0.15	2.03
R03SH285		0.17	0.09	0.27	0.08
R03SH286		0.09	0.08	0.44	0.21

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.73	0.73	0.73	
2	29	0.07	9.58	1.17	1.90
3	29	0.06	7.94	0.89	1.52
4	29	0.10	3.61	0.62	0.64
5	29	0.06	2.24	0.80	0.65

Notes:

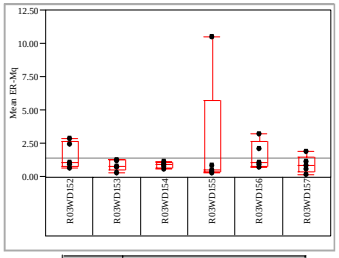
rounds individual monitoring years
n number of locations
S.D. standard deviation of arithmetic mean
min minimum concentration
max maximum concentration

grand mean for locations or rounds

ATTACHMENT G2 (Continued)

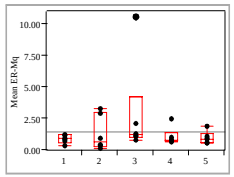
SUMMARY OF MEAN EFFECTS RANGE-MEDIAN QUOTIENT VALUES FOR INDIVIDUAL HABITATS CALCULATED USING SIX METALS AND MONITORING DATA FROM YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 3 POND



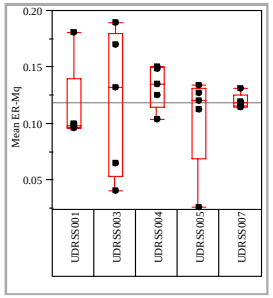
Location	Round 1	2	3	4	5
R03WD152	0.71	2.92	1.13	2.52	0.95
R03WD153	1.27	0.33	1.33	0.76	0.85
R03WD154	1.20	0.97	0.83	1.00	0.61
R03WD155	0.35	0.41	10.57	0.92	0.58
R03WD156	0.96	3.29	2.15	0.75	1.11
R03WD157	0.89	0.18	1.18	0.64	1.93

RASS 3 POND



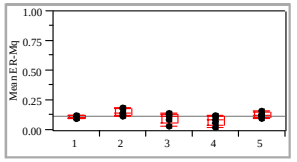
Round	Summary Statistics n	min	max	mean	S.D.
1	6	0.35	1.27	0.90	0.34
2	6	0.18	3.29	1.35	1.39
3	6	0.83	10.57	2.87	3.80
4	6	0.64	2.52	1.10	0.71
5	6	0.58	1.93	1.01	0.50

UPLAND REFERENCE



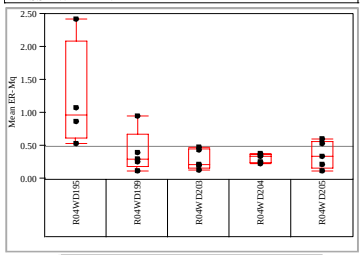
Location	Round 1	2	3	4	5
UDRSS001	0.10	0.18	0.10	0.10	0.10
UDRSS003	0.13	0.19	0.04	0.07	0.17
UDRSS004	0.10	0.15	0.15	0.13	0.14
UDRSS005	0.11	0.12	0.14	0.03	0.13
UDRSS007	0.12	0.13	0.12	0.12	0.12

UPLAND REFERENCE



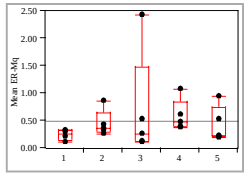
Round	Summary Statistics n	min	max	mean	S.D.
1	5	0.10	0.13	0.11	0.01
2	5	0.12	0.19	0.16	0.03
3	5	0.04	0.15	0.11	0.04
4	5	0.03	0.13	0.09	0.04
5	5	0.10	0.17	0.13	0.03

RASS 4 WETLAND



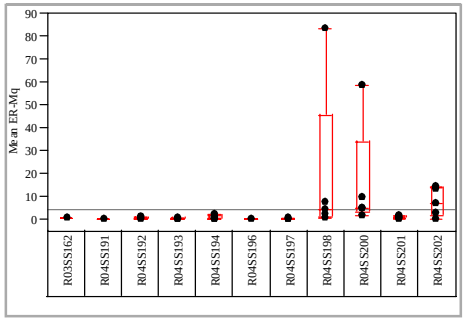
Location	Round 1	2	3	4	5
R04WD195		0.87	2.43	1.08	0.54
R04WD199	0.31	0.27	0.12	0.41	0.95
R04WD203	0.22	0.44	0.14	0.49	0.20
R04WD204	0.34	0.37	0.26	0.39	0.24
R04WD205	0.12	0.34	0.54	0.61	0.22

RASS 4 WETLAND



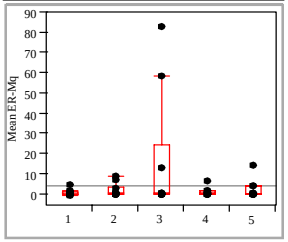
Round	Summary Statistics n	min	max	mean	S.D.
1	4	0.12	0.34	0.25	0.10
2	5	0.27	0.87	0.46	0.24
3	5	0.12	2.43	0.70	0.98
4	5	0.39	1.08	0.60	0.29
5	5	0.20	0.95	0.43	0.32

RASS 3 & 4 UPLAND



Location	Round 1	2	3	4	5
R03SS162	0.85				
R04SS191	0.34	0.51	0.41	0.33	0.39
R04SS192	0.51	1.13	0.57	0.72	0.87
R04SS193	0.19	0.21	0.56	0.74	0.12
R04SS194	0.35	1.24	0.92	2.25	0.33
R04SS196	0.44	0.32	0.30	0.39	0.27
R04SS197	0.23	0.19	0.24	0.66	0.14
R04SS198	2.41	7.56	83.52	0.78	4.31
R04SS200	4.96	9.61	58.89	1.88	4.85
R04SS201	1.70	1.06	1.16	0.18	1.03
R04SS202	0.07	3.15	13.31	7.11	14.63

RASS 3 & 4 UPLAND



Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.07	4.96	1.10	1.47
2	10	0.19	9.61	2.50	3.36
3	10	0.24	83.52	15.99	29.94
4	10	0.18	7.11	1.50	2.08
5	10	0.12	14.63	2.70	4.54

Notes:

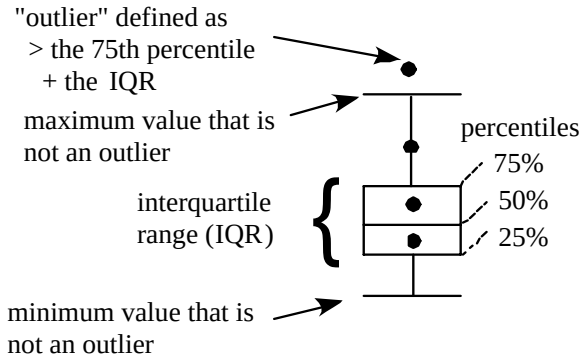
rounds	individual monitoring years	min	minimum concentration
n	number of locations	max	maximum concentration
S.D.	standard deviation of arithmetic mean		

grand mean for locations or rounds

ATTACHMENT G3

SUMMARY OF TOTAL SURFACE WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS 1 THROUGH 5

Key for
Outlier Box Plots

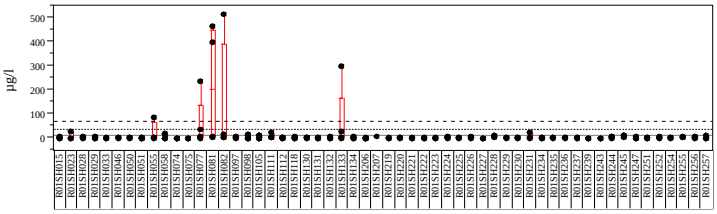


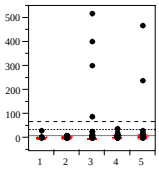
shaded line through center of each plot is the grand mean across all locations

ATTACHMENT G3
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MAIN SLOUGH

ARSENIC



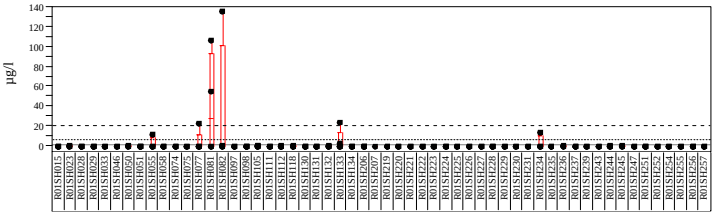


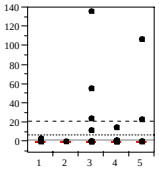
Location	Round 1	2	3	4	5
R01SH015		7.10	0.95	2.45	1.95
R01SH023			0.48	1.05	31.20
R01SH028		5.80	0.48	2.10	7.50
R01SH029		8.70	0.48	2.10	1.80
R01SH033		2.00	0.95	2.10	
R01SH046		4.90	0.95	2.55	
R01SH050		4.60	0.95	2.10	
R01SH051	1.40	2.00	0.95	3.65	5.60
R01SH055		2.00	86.50	2.10	4.05
R01SH058		2.00	0.95	21.00	17.40
R01SH074		2.00	0.48	1.60	1.35
R01SH075		2.00	0.48	1.10	
R01SH077	5.20	8.20	0.48	39.30	239.00
R01SH081		4.60	398.00	9.60	468.00
R01SH082		6.20	518.00	2.10	16.20
R01SH097			0.95	8.10	3.75
R01SH098	1.40	2.00	0.48	10.70	17.40
R01SH105	1.40	2.00	0.48	14.40	14.20
R01SH111		4.70	25.40	2.10	6.20
R01SH112	1.40	5.20	0.48	4.15	3.70
R01SH118		2.00	0.48	3.95	10.20
R01SH130		4.20	0.48	2.30	5.50
R01SH131		4.40	0.48	1.60	4.10
R01SH132	1.40	2.00	5.40	6.30	
R01SH133	29.80	5.00	300.00	1.20	3.80
R01SH134		2.00	0.48	3.90	6.70
R01SH206	1.40	2.00	0.95	1.85	2.95
R01SH207					7.10

Location	Round 1	2	3	4	5
R01SH219		2.00	0.95	2.45	
R01SH220		4.60	0.95	2.60	
R01SH221		2.00	0.95	3.00	
R01SH222		2.00	0.95	3.10	
R01SH223		4.50	0.95	1.45	
R01SH224		5.60	0.48	6.30	2.25
R01SH225		4.50	0.95	3.20	
R01SH226		2.00	9.10	4.10	
R01SH227		2.00	0.95	1.05	
R01SH228		7.10	14.50	4.10	7.50
R01SH229		4.20	0.95	4.90	
R01SH230		5.30		4.90	1.50
R01SH231		2.00	24.60	6.00	
R01SH234		2.00	0.95	3.40	6.20
R01SH235		5.50	0.95	3.80	
R01SH236		6.00	0.95	2.65	
R01SH237		2.00	0.95	3.10	3.75
R01SH239		2.00	0.48	1.65	
R01SH243		2.00	0.48	1.30	
R01SH244		6.30	0.48	3.20	7.90
R01SH245		4.10	12.50	14.40	
R01SH247		2.00	0.95	9.20	
R01SH251		2.00	0.48	4.60	5.30
R01SH252		4.90	0.48	9.50	
R01SH254		4.60	0.95	3.80	
R01SH255		4.90	7.00	4.85	
R01SH256		6.20	0.95	9.30	4.55
R01SH257		2.00	0.48	10.90	

Round	Summary Statistics n	min	max	mean	S.D.
1	8	1.40	29.80	5.43	9.94
2	53	2.00	8.70	3.81	1.93
3	54	0.48	518.00	26.53	95.96
4	55	1.05	39.30	5.24	6.12
5	31	1.35	468.00	29.63	91.59

CADMIUM





Location	Round 1	2	3	4	5
R01SH015		0.15	0.19	0.30	0.15
R01SH023			0.10	0.15	0.90
R01SH028		0.50	0.10	0.30	0.30
R01SH029		0.15	0.10	0.30	0.15
R01SH033		0.15	0.19	0.30	
R01SH046		0.15	0.19	0.18	
R01SH050		0.15	0.19	1.20	
R01SH051	0.10	0.15	0.19	0.30	0.15
R01SH055		0.15	11.90	0.30	0.15
R01SH058		0.50	0.19	0.22	0.33
R01SH074		0.15	0.10	0.30	0.44
R01SH075		0.15	0.10	0.30	
R01SH077	0.10	0.15	0.10	0.23	23.50
R01SH081		0.15	55.20	0.44	107.00
R01SH082		0.15	136.00	0.30	0.55
R01SH097			0.19	0.15	0.48
R01SH098	0.10	0.15	0.19	0.30	0.37
R01SH105	0.10	0.15	0.19	1.50	0.76
R01SH111		0.15	0.19	0.38	0.30
R01SH112	0.10	0.15	0.19	0.30	0.70
R01SH118		0.15	0.10	0.30	0.76
R01SH130		0.15	0.19	0.30	0.35
R01SH131		0.50	0.10	0.30	0.15
R01SH132	0.10	0.42	0.10	0.68	
R01SH133	3.20	0.15	24.60	0.30	0.35
R01SH134		0.15	0.10	0.30	0.15
R01SH206	0.10	0.15	0.19	0.30	0.15
R01SH207					0.27

Location	Round 1	2	3	4	5
R01SH219		0.15	0.19	0.30	
R01SH220		0.15	0.19	0.15	
R01SH221		0.15	0.19	0.15	
R01SH222		0.15	0.19	0.15	
R01SH223		0.15	0.19	0.30	
R01SH224		0.15	0.10	0.15	0.15
R01SH225		0.50	0.19	0.30	
R01SH226		0.15	0.19	0.30	
R01SH227		0.15	0.19	0.15	
R01SH228		0.15	0.19	0.15	0.33
R01SH229		0.15	0.19	0.15	
R01SH230		0.15		0.15	0.15
R01SH231		0.15	0.19	0.15	
R01SH234		0.15	0.19	14.60	0.15
R01SH235		0.15	0.19	0.30	
R01SH236		0.15	0.19	0.80	
R01SH237		0.15	0.19	0.30	0.40
R01SH239		0.50	0.10	0.30	
R01SH243		0.15	0.10	0.30	
R01SH244		0.15	0.10	0.30	0.56
R01SH245		0.15	0.10	0.79	
R01SH247		0.15	0.19	0.15	
R01SH251		0.15	0.10	0.30	0.15
R01SH252		0.15	0.10	0.15	
R01SH254		0.15	0.19	0.30	
R01SH255		0.15	0.10	0.30	
R01SH256		0.15	0.19	0.30	0.15
R01SH257		0.50	0.10	0.33	

Round	Summary Statistics n	min	max	mean	S.D.
1	8	0.10	3.20	0.49	1.10
2	53	0.15	0.50	0.19	0.12
3	54	0.10	136.00	4.36	20.03
4	55	0.15	14.60	0.59	1.94
5	31	0.15	107.00	4.53	19.47

Notes:

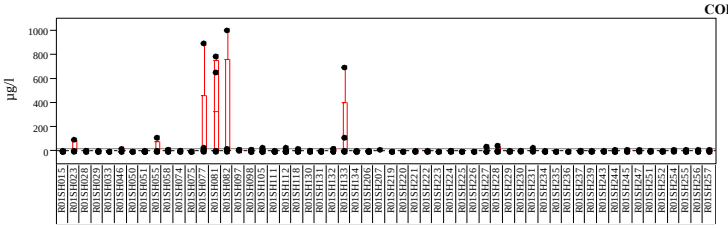
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

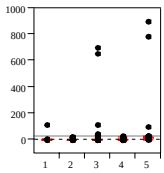
chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MAIN SLOUGH

COPPER



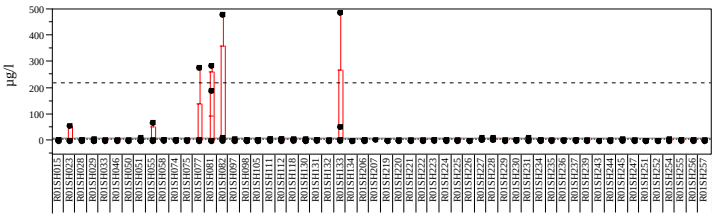


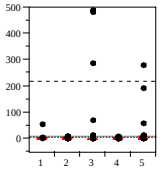
Location	Round 1	2	3	4	5
R01SH015		0.50	0.70	2.55	4.85
R01SH023			0.36	5.10	99.20
R01SH028		0.50	0.36	6.30	11.60
R01SH029		0.50	0.36	6.70	4.05
R01SH033		0.50	0.70	2.25	
R01SH046		0.50	21.70	3.40	
R01SH050		0.50	0.70	3.40	
R01SH051	0.40	0.50	0.70	3.75	12.00
R01SH055		0.50	114.00	1.50	5.40
R01SH058		0.50	0.70	18.70	19.50
R01SH074		0.50	0.36	5.60	6.70
R01SH075		0.50	0.36	3.00	
R01SH077	8.00	16.60	0.36	30.20	900.00
R01SH081		0.50	656.00	8.50	788.00
R01SH082		14.60	1,010.00	3.50	26.60
R01SH097			17.90	9.80	16.30
R01SH098	0.40	0.50	0.36	18.40	18.10
R01SH105	0.40	0.50	0.36	15.90	31.20
R01SH111		0.50	0.70	2.00	12.00
R01SH112	0.40	0.50	0.36	9.50	29.20
R01SH118		0.50	0.36	4.30	29.00
R01SH130		0.50	0.36	9.10	10.10
R01SH131		0.50	0.36	10.30	2.40
R01SH132	0.40	25.50	0.36	22.30	
R01SH133	116.00	0.50	700.00	8.70	2.70
R01SH134		0.50	0.36	4.80	2.45
R01SH206	0.40	0.50	0.70	3.05	4.30
R01SH207					14.00

Location	Round 1	2	3	4	5
R01SH219		0.50	0.70	2.75	
R01SH220		0.50	0.70	2.70	
R01SH221		0.50	0.70	6.90	
R01SH222		0.50	0.70	9.00	
R01SH223		0.50	0.70	2.05	
R01SH224		0.50	0.36	11.10	9.90
R01SH225		0.50	0.70	1.40	
R01SH226		0.50	0.70	1.30	
R01SH227		0.50	39.00	1.70	
R01SH228		0.50	48.00	3.00	10.80
R01SH229		0.50	0.70	5.10	
R01SH230		0.50		5.60	10.40
R01SH231		0.50	35.80	6.10	
R01SH234		0.50	0.70	2.10	9.20
R01SH235		0.50	0.70	1.65	
R01SH236		0.50	0.70	3.50	
R01SH237		0.50	0.70	4.60	11.00
R01SH239		0.50	0.36	9.30	
R01SH243		0.50	0.36	9.60	
R01SH244		0.50	0.36	3.45	13.50
R01SH245		0.50	0.36	16.90	
R01SH247		18.90	0.70	8.60	
R01SH251		0.50	0.36	8.30	5.70
R01SH252		0.50	0.36	8.50	
R01SH254		0.50	17.10	7.30	
R01SH255		0.50	0.36	15.60	
R01SH256		0.50	0.70	12.60	8.60
R01SH257		0.50	0.36	17.10	

Round	Summary Statistics n	min	max	mean	S.D.
1	8	0.40	116.00	15.80	40.57
2	53	0.50	25.50	1.89	5.04
3	54	0.36	1,010.00	49.67	185.63
4	55	1.30	30.20	7.46	6.00
5	31	2.40	900.00	68.67	208.22

LEAD





Location	Round 1	2	3	4	5
R01SH015		1.90	0.70	1.15	2.40
R01SH023			0.35	0.85	57.00
R01SH028		1.80	0.35	1.30	3.60
R01SH029		5.40	0.35	1.30	0.85
R01SH033		1.70	0.70	1.30	
R01SH046		2.20	0.70	1.30	
R01SH050		1.80	0.70	1.30	
R01SH051	0.75	3.30	0.70	1.30	9.80
R01SH055		0.50	70.30	2.25	0.85
R01SH058		4.10	0.70	2.10	3.15
R01SH074		1.90	0.35	1.30	3.20
R01SH075		1.80	0.35	1.05	
R01SH077	0.75	3.10	0.35	4.10	280.00
R01SH081		0.50	287.00	0.55	191.00
R01SH082		0.50	479.00	1.80	11.40
R01SH097			0.70	0.55	7.60
R01SH098	0.75	1.90	0.70	0.80	2.50
R01SH105	0.75	4.60	0.70	1.40	2.50
R01SH111		6.20	0.70	2.40	5.40
R01SH112	0.75	5.40	0.70	5.40	2.50
R01SH118		5.40	0.35	1.70	2.50
R01SH130		7.20	0.70	1.30	0.95
R01SH131		2.40	0.35	3.20	1.70
R01SH132	0.75	0.50	0.35	4.30	
R01SH133	51.50	0.50	490.00	1.75	3.20
R01SH134		0.50	0.35	0.95	1.40
R01SH206	2.50	0.50	0.70	1.15	2.50
R01SH207					3.30

Location	Round 1	2	3	4	5
R01SH219		0.50	0.70	0.90	
R01SH220		3.00	0.70	0.85	
R01SH221		1.70	0.70	0.85	
R01SH222		3.50	0.70	1.15	
R01SH223		2.80	0.70	1.70	
R01SH224		4.40	0.35	0.55	2.15
R01SH225		4.00	0.70	1.30	
R01SH226		0.50	0.70	1.30	
R01SH227		1.80	12.30	4.10	
R01SH228		6.40	12.30	2.10	5.10
R01SH229		2.60	0.70	0.55	
R01SH230		2.10		0.55	2.75
R01SH231		0.50	11.20	0.55	
R01SH234		3.40	0.70	1.30	2.50
R01SH235		2.00	0.70	1.30	
R01SH236		2.90	0.70	1.30	
R01SH237		3.30	0.70	2.30	0.85
R01SH239		2.10	0.35	0.90	
R01SH243		0.50	0.35	1.15	
R01SH244		0.50	0.35	1.70	0.50
R01SH245		0.50	6.60	2.60	
R01SH247		2.00	0.70	0.55	
R01SH251		0.50	0.35	0.85	0.85
R01SH252		0.50	0.35	0.55	
R01SH254		5.40	0.70	1.00	
R01SH255		4.20	0.35	2.00	
R01SH256		3.80	0.70	1.70	0.85
R01SH257		3.10	0.35	1.40	

Round	Summary Statistics n	min	max	mean	S.D.
1	8	0.75	51.50	7.31	17.86
2	53	0.50	7.20	2.53	1.82
3	54	0.35	490.00	25.82	99.18
4	55	0.55	5.40	1.54	1.02
5	31	0.50	280.00	19.83	59.55

Notes:

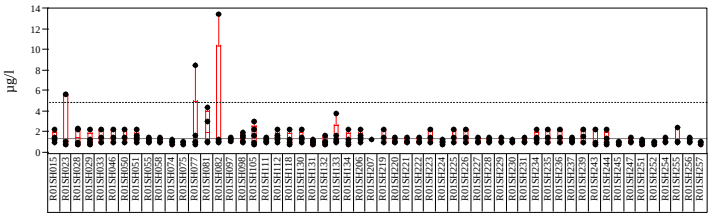
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

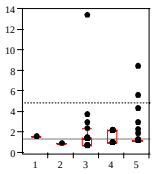
chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

MAIN SLOUGH

SELENIUM



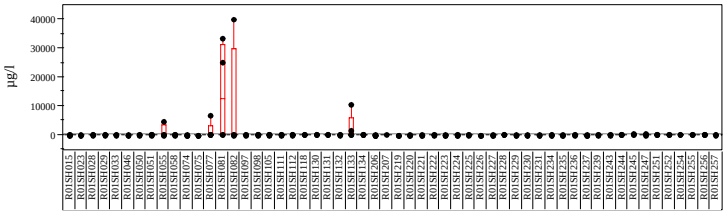


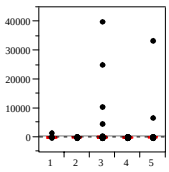
Location	Round 1	2	3	4	5
R01SH015		1.00	1.50	2.20	1.25
R01SH023			0.75	1.10	5.60
R01SH028		1.00	0.75	2.20	2.35
R01SH029		1.00	0.75	2.20	1.25
R01SH033		1.00	1.50	2.20	
R01SH046		1.00	1.50	2.20	
R01SH050		1.00	1.50	2.20	
R01SH051	1.70	1.00	1.50	2.20	1.25
R01SH055		1.00	1.50	1.10	1.25
R01SH058		1.00	1.50	1.10	1.25
R01SH074		1.00	0.75	1.10	1.25
R01SH075		1.00	0.75	1.10	
R01SH077	1.70	1.00	0.75	1.10	8.50
R01SH081		1.00	3.00	1.10	4.40
R01SH082		1.00	13.40	1.10	1.25
R01SH097			1.50	1.10	1.25
R01SH098	1.70	1.00	1.50	1.10	1.90
R01SH105	1.70	1.00	0.75	2.20	3.00
R01SH111		1.00	1.50	1.10	1.25
R01SH112	1.70	1.00	1.50	2.20	1.25
R01SH118		1.00	0.75	2.20	1.25
R01SH130		1.00	1.50	2.20	1.25
R01SH131		1.00	0.75	1.10	1.25
R01SH132	1.70	1.00	0.75	1.10	
R01SH133	1.70	1.00	3.75	1.10	1.25
R01SH134		1.00	0.75	2.20	1.25
R01SH206	1.70	1.00	1.50	2.20	1.25
R01SH207					1.25

Location	Round 1	2	3	4	5
R01SH219		1.00	1.50	2.20	
R01SH220		1.00	1.50	1.10	
R01SH221		1.00	1.50	1.10	
R01SH222		1.00	1.50	1.10	
R01SH223		1.00	1.50	2.20	
R01SH224		1.00	0.75	1.10	1.25
R01SH225		1.00	1.50	2.20	
R01SH226		1.00	1.50	2.20	
R01SH227		1.00	1.50	1.10	
R01SH228		1.00	1.50	1.10	1.25
R01SH229		1.00	1.50	1.10	
R01SH230		1.00		1.10	1.25
R01SH231		1.00	1.50	1.10	
R01SH234		1.00	1.50	2.20	1.25
R01SH235		1.00	1.50	2.20	
R01SH236		1.00	1.50	2.20	
R01SH237		1.00	1.50	1.10	1.25
R01SH239		1.00	1.60	2.20	
R01SH243		1.00	0.75	2.20	
R01SH244		1.00	0.75	2.20	1.40
R01SH245		1.00	0.75	1.10	
R01SH247		1.00	1.50	1.10	
R01SH251		1.00	0.75	1.10	1.25
R01SH252		1.00	0.75	1.10	
R01SH254		1.00	1.50	1.10	
R01SH255		1.00	2.40	1.10	
R01SH256		1.00	1.50	1.10	1.25
R01SH257		1.00	0.75	1.10	

Round	Summary Statistics n	min	max	mean	S.D.
1	8	1.70	1.70	1.70	0.00
2	53	1.00	1.00	1.00	0.00
3	54	0.75	13.40	1.56	1.74
4	55	1.10	2.20	1.56	0.55
5	31	1.25	8.50	1.84	1.58

ZINC





Location	Round 1	2	3	4	5
R01SH015		65.20	0.30	4.50	104.00
R01SH023			11.00	9.50	345.00
R01SH028		49.40	30.20	38.50	104.00
R01SH029		74.40	36.40	39.80	23.10
R01SH033		57.10	116.00	6.30	
R01SH046		34.30	0.30	44.70	
R01SH050		61.00	0.30	44.00	
R01SH051	90.20	88.00	0.30	54.40	130.00
R01SH055		55.80	4,750.00	7.35	103.00
R01SH058		97.20	0.30	116.00	127.00
R01SH074		25.80	28.00	20.15	88.20
R01SH075		28.20	24.50	21.35	
R01SH077	89.30	87.30	60.30	212.00	6,710.00
R01SH081		205.00	25,200.00	64.30	33,700.00
R01SH082		124.00	40,100.00	15.35	359.00
R01SH097			0.30	87.00	98.80
R01SH098	0.15	35.50	76.00	140.00	123.00
R01SH105	0.15	131.00	72.00	136.00	237.00
R01SH111		208.00	166.00	20.70	145.00
R01SH112	0.15	117.00	72.20	41.20	214.00
R01SH118		120.00	85.50	49.50	263.00
R01SH130		192.00	82.50	56.50	145.00
R01SH131		76.70	103.00	37.35	85.00
R01SH132	0.15	177.00	111.00	247.00	
R01SH133	1,440.00	181.00	10,700.00	39.25	85.90
R01SH134		69.60	68.70	71.60	64.90
R01SH206	224.00	0.50	0.30	32.80	22.30
R01SH207					196.00

Location	Round 1	2	3	4	5
R01SH219		0.50	0.30	27.30	
R01SH220		44.60	0.30	11.60	
R01SH221		81.30	0.30	19.00	
R01SH222		78.30	0.30	36.20	
R01SH223		90.60	0.30	6.10	
R01SH224		96.80	0.15	40.20	32.10
R01SH225		37.70	190.00	5.90	
R01SH226		0.50	0.30	17.10	
R01SH227		0.50	132.00	6.50	
R01SH228		154.00	233.00	80.10	91.90
R01SH229		77.20	0.30	22.80	
R01SH230		73.60		24.40	15.25
R01SH231		0.50	176.00	25.70	
R01SH234		71.00	0.30	5.85	85.50
R01SH235		58.80	0.30	4.25	
R01SH236		51.60	0.30	41.90	
R01SH237		118.00	0.30	24.70	27.50
R01SH239		97.50	0.15	59.40	
R01SH243		44.80	0.15	68.00	
R01SH244		186.00	166.00	45.10	172.00
R01SH245		147.00	471.00	243.00	
R01SH247		0.50	414.00	53.80	
R01SH251		146.00	354.00	77.30	86.70
R01SH252		97.30	269.00	55.70	
R01SH254		167.00	186.00	84.00	
R01SH255		156.00	190.00	90.90	
R01SH256		131.00	170.00	94.90	120.00
R01SH257		98.60	0.15	126.00	

Round	Summary Statistics n	min	max	mean	S.D.
1	8	0.15	1,440.00	230.51	494.95
2	53	0.50	208.00	88.08	57.00
3	54	0.15	40,100.00	1,571.30	6,512.31
4	55	4.25	247.00	55.54	55.16
5	31	15.25	33,700.00	1,422.71	6,106.43

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 1 DITCHES

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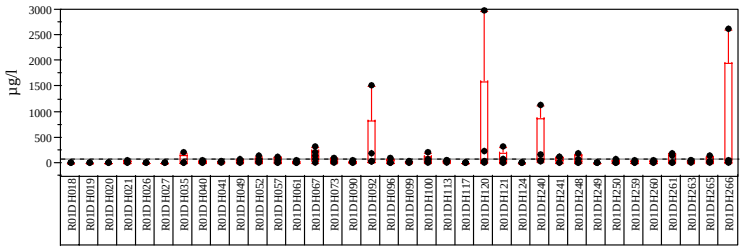
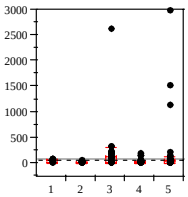


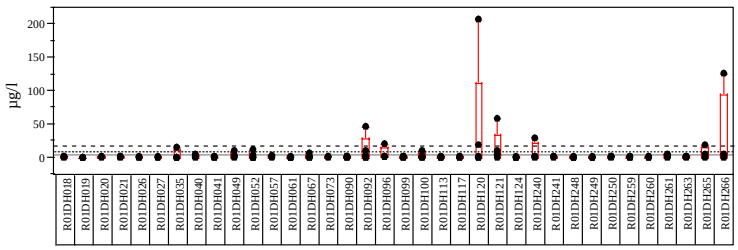


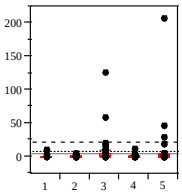
Location	Round 1	2	3	4	5
R01DH018		2.00	0.95	1.20	
R01DH019		2.00	0.48	1.05	
R01DH020		2.00	0.95	5.90	
R01DH021		2.00	0.95	38.60	
R01DH026		2.00	0.95	2.00	
R01DH027		2.00	0.95	4.30	
R01DH035		2.00	205.00	5.70	1.65
R01DH040		2.00	20.60	1.85	41.00
R01DH041	29.40	18.00	31.80	2.00	
R01DH049		2.00	62.40	2.10	47.70
R01DH052	55.30	12.90	17.00	142.00	1.35
R01DH057		4.90	120.00	2.10	40.70
R01DH061	4.00	2.00	12.40	4.50	40.00
R01DH067	69.30	2.00	318.00	125.00	197.00
R01DH073		31.30	88.70	2.40	
R01DH090	35.20	13.00	0.95	12.10	7.40
R01DH092	20.50	11.20	189.00	19.50	1,500.00
R01DH096		2.00	96.40	4.90	4.90

Location	Round 1	2	3	4	5
R01DH099	15.60	2.00	0.95	15.10	10.20
R01DH100	17.40	4.40	212.00	26.00	61.60
R01DH113	35.90	15.30	29.10	32.50	6.05
R01DH117		2.00	0.48	1.55	5.80
R01DH120	3.30	17.10	226.00	20.90	2,970.00
R01DH121	58.80	7.90	325.00	8.60	63.00
R01DH124		2.00	0.48	2.00	9.10
R01DH240		29.20	146.00	52.00	1,120.00
R01DH241		2.00	110.00	3.30	113.00
R01DH248		7.70	187.00	3.40	59.50
R01DH249		2.00	0.48	6.20	4.60
R01DH250		7.30	0.95	5.15	57.10
R01DH259		2.00	0.48	4.45	42.80
R01DH260		2.00	0.48	14.00	42.80
R01DH261		5.50	140.00	178.00	7.05
R01DH263		6.00	16.20	43.10	49.40
R01DH265		2.00	29.60	20.60	144.00
R01DH266		42.00	2,610.00	15.20	8.05

Round	Summary Statistics n	min	max	mean	S.D.
1	11	3.30	69.30	31.34	22.14
2	36	2.00	42.00	7.60	9.55
3	36	0.48	2,610.00	144.52	433.20
4	36	1.05	178.00	23.03	40.90
5	28	1.35	2,970.00	237.71	633.74

CADMIUM





Location	Round 1	2	3	4	5
R01DH018		0.15	0.19	0.30	
R01DH019		0.15	0.10	0.15	
R01DH020		0.50	0.19	0.15	
R01DH021		0.50	0.19	0.15	
R01DH026		0.15	0.19	0.15	
R01DH027		0.15	0.19	0.15	
R01DH035		0.15	14.80	0.15	0.15
R01DH040		0.15	0.19	0.50	4.00
R01DH041	0.10	0.15	0.19	0.30	
R01DH049		0.15	9.10	0.30	2.60
R01DH052	2.10	0.15	0.10	11.70	0.15
R01DH057		0.15	0.19	0.30	2.60
R01DH061	0.10	0.15	0.10	0.15	0.38
R01DH067	0.10	0.50	5.40	0.41	0.15
R01DH073		0.15	0.19	0.30	
R01DH090	0.10	0.51	0.19	0.52	0.15
R01DH092	0.10	2.00	10.20	0.15	46.50
R01DH096		0.35	20.00	0.34	0.20

Location	Round 1	2	3	4	5
R01DH099	0.10	0.50	0.19	0.55	0.15
R01DH100	0.10	0.50	10.40	0.15	0.35
R01DH113	0.10	0.15	0.19	0.15	0.20
R01DH117		0.15	0.10	0.18	0.46
R01DH120	0.10	0.15	18.80	0.46	207.00
R01DH121	9.70	0.15	58.60	2.00	5.20
R01DH124		0.15	0.10	0.17	0.67
R01DH240		0.50	0.19	0.15	29.20
R01DH241		0.50	0.19	0.30	0.15
R01DH248		0.15	0.38	0.15	0.15
R01DH249		0.15	0.10	0.15	0.27
R01DH250		0.50	0.19	0.15	0.62
R01DH259		0.15	0.19	0.15	0.75
R01DH260		0.15	0.19	0.15	0.50
R01DH261		0.50	4.70	2.10	0.16
R01DH263		0.50	0.10	1.40	0.31
R01DH265		0.15	5.30	0.87	17.70
R01DH266		3.80	126.00	0.15	2.30

Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.10	9.70	1.15	2.90
2	36	0.15	3.80	0.42	0.67
3	36	0.10	126.00	7.99	22.90
4	36	0.15	11.70	0.71	1.94
5	28	0.15	207.00	11.54	39.68

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 1 DITCHES

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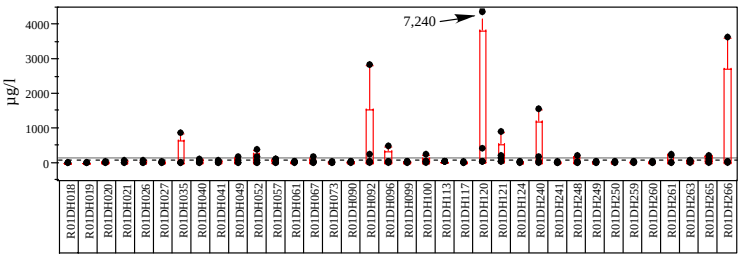

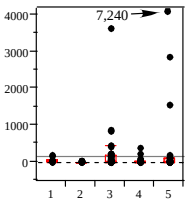

Location	Round 1	2	3	4	5
R01DH018		0.50	0.70	1.90	
R01DH019		0.50	0.36	2.20	
R01DH020		0.50	0.70	8.75	
R01DH021		0.50	0.70	42.20	
R01DH026		0.50	60.20	2.70	
R01DH027		0.50	0.70	4.70	
R01DH035		0.50	838.00	3.15	2.10
R01DH040		0.50	35.70	2.20	105.00
R01DH041	56.80	0.50	1.40	8.50	
R01DH049		0.50	150.00	1.25	53.10
R01DH052	145.00	0.50	42.90	384.00	2.40
R01DH057		0.50	83.20	2.95	85.30
R01DH061	0.40	0.50	31.80	5.05	7.90
R01DH067	13.20	0.50	160.00	18.00	1.25
R01DH073		36.20	0.70	2.70	
R01DH090	14.30	21.00	0.70	3.35	25.60
R01DH092	0.40	24.10	224.00	4.50	2,850.00
R01DH096		0.50	460.00	15.20	4.10

Location	Round 1	2	3	4	5
R01DH099	15.70	0.50	0.70	4.55	8.00
R01DH100	13.50	0.50	231.00	5.80	15.70
R01DH113	26.00	35.70	34.50	10.10	3.90
R01DH117		0.50	0.36	3.35	8.10
R01DH120	7.00	33.00	407.00	9.25	7,240.00
R01DH121	198.00	35.50	877.00	8.15	113.00
R01DH124		0.50	0.36	3.50	9.20
R01DH240		0.50	146.00	8.10	1,540.00
R01DH241		0.50	0.70	4.60	2.50
R01DH248		2.00	210.00	2.25	27.40
R01DH249		2.00	0.36	4.25	7.20
R01DH250		0.50	0.70	3.65	21.00
R01DH259		2.00	0.36	6.55	35.50
R01DH260		2.00	0.36	5.95	24.80
R01DH261		0.50	199.00	233.00	3.35
R01DH263		0.50	48.00	72.20	29.50
R01DH265		2.00	107.00	8.95	201.00
R01DH266		29.80	3,640.00	7.40	3.20

Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.40	198.00	44.57	65.68
2	36	0.50	36.20	6.59	12.31
3	36	0.36	3,640.00	222.09	623.56
4	36	1.25	384.00	25.41	73.09
5	28	1.25	7,240.00	443.93	1,458.98

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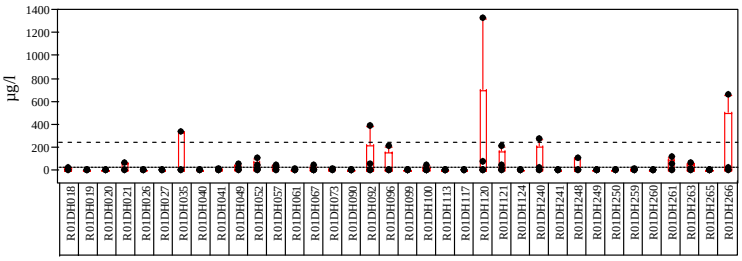
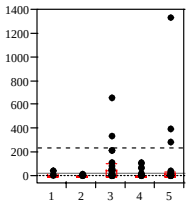




Location	Round 1	2	3	4	5
R01DH018		3.20	0.70	20.10	
R01DH019		0.50	0.35	1.40	
R01DH020		1.80	0.70	3.30	
R01DH021		3.00	0.70	67.70	
R01DH026		2.30	0.70	1.30	
R01DH027		2.20	0.70	1.00	
R01DH035		2.10	336.00	1.30	
R01DH040		2.10	0.70	0.65	
R01DH041	14.20	2.70	1.40	7.10	
R01DH049		0.50	51.60	2.05	26.20
R01DH052	45.00	3.90	13.30	105.00	0.85
R01DH057		2.10	39.30	6.15	45.30
R01DH061	0.75	1.40	9.40	0.85	2.75
R01DH067	0.75	1.30	45.10	3.60	0.85
R01DH073		11.70	0.70	2.45	
R01DH090	0.75	3.20	0.70	0.65	0.50
R01DH092	0.75	2.80	53.90	1.05	392.00
R01DH096		0.50	213.00	2.60	2.25

Location	Round 1	2	3	4	5
R01DH099	0.75	3.30	0.70	1.20	0.95
R01DH100	2.90	1.20	46.40	0.65	0.70
R01DH113	0.75	2.70	0.70	0.65	2.25
R01DH117		0.50	0.35	1.30	0.50
R01DH120	0.75	3.40	81.40	2.00	1,330.00
R01DH121	44.70	6.00	215.00	0.65	
R01DH124		0.50	0.35	1.30	0.50
R01DH240		1.80	27.80	0.50	278.00
R01DH241		0.50	5.00	1.05	0.85
R01DH248		8.90	108.00	6.30	
R01DH249		1.40	0.35	3.10	2.50
R01DH250		4.80	0.70	0.85	3.00
R01DH259		2.10	0.35	0.75	16.60
R01DH260		2.20	0.70	4.75	5.60
R01DH261		0.50	56.10	114.00	3.65
R01DH263		3.20	13.50	65.50	3.45
R01DH265		0.50	0.70	0.50	4.70
R01DH266		2.00	657.00	0.85	25.40

Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.75	45.00	10.19	17.59
2	36	0.50	11.70	2.58	2.32
3	36	0.35	657.00	55.11	126.58
4	36	0.50	114.00	12.06	28.43
5	24	0.50	1,330.00	89.56	280.62

Notes:

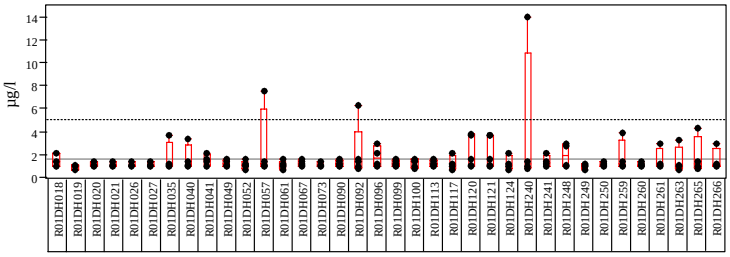
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

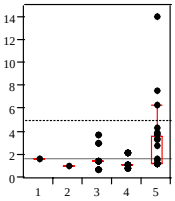
chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 1 DITCHES

SELENIUM



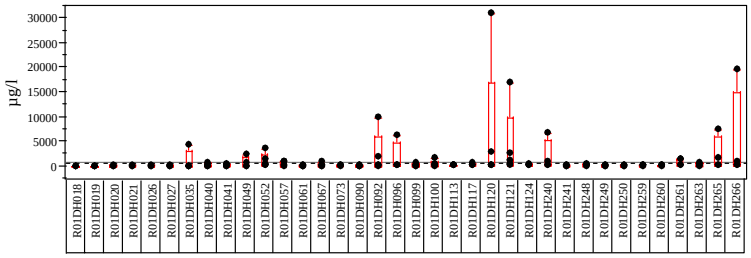


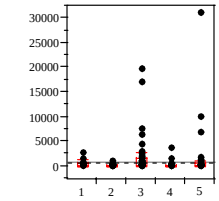
Location	Round 1	2	3	4	5
R01DH018		1.00	1.50	2.20	
R01DH019		1.00	0.75	1.10	
R01DH020		1.00	1.50	1.10	
R01DH021		1.00	1.50	1.10	
R01DH026		1.00	1.50	1.10	
R01DH027		1.00	1.50	1.10	
R01DH035		1.00	3.75	1.10	1.25
R01DH040		1.00	1.50	1.10	3.40
R01DH041	1.70	1.00	1.50	2.20	
R01DH049		1.00	1.50	1.10	1.65
R01DH052	1.70	1.00	0.75	1.10	1.25
R01DH057		1.00	1.50	1.10	7.60
R01DH061	1.70	1.00	0.75	1.10	1.25
R01DH067	1.70	1.00	1.50	1.10	1.25
R01DH073		1.00	1.50	1.10	
R01DH090	1.70	1.00	1.50	1.10	1.25
R01DH092	1.70	1.00	1.50	0.85	6.40
R01DH096		1.00	3.00	2.20	1.25

Location	Round 1	2	3	4	5
R01DH099	1.70	1.00	1.50	1.10	1.25
R01DH100	1.70	1.00	1.50	0.85	1.55
R01DH113	1.70	1.00	1.50	1.10	1.25
R01DH117		1.00	0.75	2.20	1.25
R01DH120	1.70	1.00	3.75	1.10	3.90
R01DH121	1.70	1.00	3.75	1.10	3.75
R01DH124		1.00	0.75	2.20	1.25
R01DH240		1.00	1.50	0.85	14.10
R01DH241		1.00	1.50	2.20	1.25
R01DH248		1.00	3.00	1.10	2.85
R01DH249		1.00	0.75	1.10	1.25
R01DH250		1.00	1.50	1.10	1.25
R01DH259		1.00	1.50	1.10	4.00
R01DH260		1.00	1.50	1.10	1.25
R01DH261		1.00	3.00	1.10	1.25
R01DH263		1.00	0.75	1.10	3.30
R01DH265		1.00	1.50	0.85	4.40
R01DH266		1.00	3.00	1.10	1.25

Round	Summary Statistics n	min	max	mean	S.D.
1	11	1.70	1.70	1.70	0.00
2	36	1.00	1.00	1.00	0.00
3	36	0.75	3.75	1.71	0.87
4	36	0.85	2.20	1.26	0.44
5	28	1.25	14.10	2.75	2.80

ZINC





Location	Round 1	2	3	4	5
R01DH018		0.50	27.70	4.15	
R01DH019		0.50	0.15	6.85	
R01DH020		42.70	25.40	62.30	
R01DH021		28.20	29.90	130.00	
R01DH026		39.80	77.70	38.30	
R01DH027		37.20	65.90	18.70	
R01DH035		31.20	4,240.00	20.60	19.60
R01DH040		47.80	84.90	17.00	705.00
R01DH041	422.00	110.00	0.60	39.50	
R01DH049		0.50	2,290.00	4.60	644.00
R01DH052	1,470.00	122.00	430.00	3,490.00	52.80
R01DH057		59.70	826.00	23.00	838.00
R01DH061	0.15	0.50	170.00	19.00	103.00
R01DH067	74.90	0.50	786.00	84.30	9.05
R01DH073		184.00	103.00	20.25	
R01DH090	0.15	106.00	0.30	93.10	8.20
R01DH092	0.15	215.00	1,940.00	67.30	9,880.00
R01DH096		121.00	6,250.00	146.00	165.00

Location	Round 1	2	3	4	5
R01DH099	606.00	65.90	0.30	108.00	33.70
R01DH100	354.00	46.00	1,640.00	71.50	105.00
R01DH113	103.00	101.00	177.00	77.80	58.30
R01DH117		114.00	657.00	65.20	149.00
R01DH120	60.00	215.00	2,740.00	77.80	31,100.00
R01DH121	2,680.00	387.00	17,000.00	111.00	1,100.00
R01DH124		154.00	403.00	81.50	191.00
R01DH240		69.50	860.00	52.30	6,730.00
R01DH241		66.40	171.00	8.75	25.85
R01DH248		114.00	485.00	29.20	192.00
R01DH249		1.50	100.00	13.70	114.00
R01DH250		51.80	0.30	54.00	148.00
R01DH259		39.80	89.40	56.60	276.00
R01DH260		44.60	105.00	86.10	190.00
R01DH261		53.30	1,390.00	1,330.00	60.70
R01DH263		47.20	666.00	315.00	156.00
R01DH265		158.00	7,380.00	119.00	1,690.00
R01DH266		807.00	19,700.00	62.10	83.00

Round	Summary Statistics n	min	max	mean	S.D.
1	11	0.15	2,680.00	524.58	837.06
2	36	0.50	807.00	102.31	144.19
3	36	0.15	19,700.00	1,969.77	4,387.32
4	36	4.15	3,490.00	194.57	605.70
5	28	8.20	31,100.00	1,958.11	6,112.45

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK

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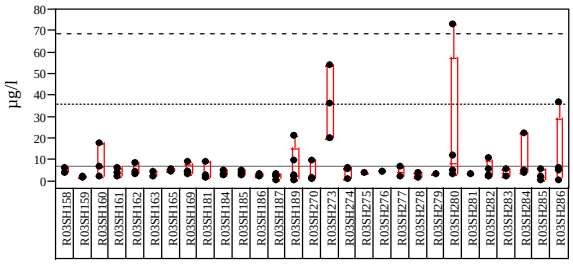
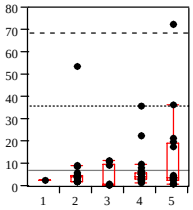


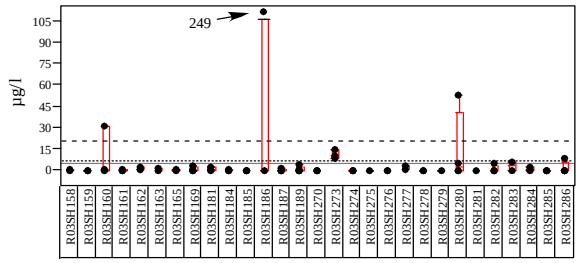


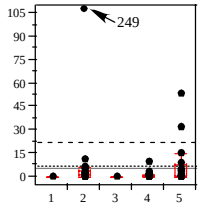
Location	Round 1	2	3	4	5
R03SH158		4.10		6.50	
R03SH159				2.40	1.35
R03SH160		2.00		6.80	17.90
R03SH161		2.00		6.10	3.65
R03SH162		4.40		8.30	3.35
R03SH163		2.00		4.40	
R03SH165		4.70		5.70	
R03SH169		4.50	9.30	3.10	4.30
R03SH181		9.10		2.55	1.35
R03SH184		4.80		2.80	3.20
R03SH185		5.10		3.00	4.10
R03SH186		2.00		3.50	
R03SH187		2.00	0.48	3.00	3.60
R03SH189	2.80	2.00	0.48	9.80	21.40
R03SH270		9.50	0.95	1.65	

Location	Round 1	2	3	4	5
R03SH273		54.00		36.00	20.00
R03SH274		6.20	0.95	5.40	
R03SH275				4.20	
R03SH276		4.70		4.30	
R03SH277		2.00		6.70	
R03SH278				3.65	1.35
R03SH279				3.50	
R03SH280		5.00	11.80	3.10	72.90
R03SH281				3.10	
R03SH282		2.00	11.10	5.60	2.65
R03SH283		2.00		5.70	
R03SH284		4.00		22.60	5.20
R03SH285		2.00	0.48	5.60	
R03SH286		5.20	0.48	6.00	36.80

Round	Summary Statistics n	min	max	mean	S.D.
1	1	2.80	2.80	2.80	
2	24	2.00	54.00	6.05	10.44
3	9	0.48	11.80	4.00	5.09
4	29	1.65	36.00	6.38	6.86
5	16	1.35	72.90	12.69	18.96

CADMIUM





Location	Round 1	2	3	4	5
R03SH158		1.30		0.37	
R03SH159				0.30	0.15
R03SH160		0.96		0.34	31.70
R03SH161		1.10		0.30	0.15
R03SH162		1.30		1.10	2.80
R03SH163		1.90		0.30	
R03SH165		1.20		0.15	
R03SH169		1.40	0.10	0.15	4.00
R03SH181		2.60		0.97	0.15
R03SH184		0.15		1.10	0.15
R03SH185		0.15		0.64	0.16
R03SH186		249.00		0.38	
R03SH187		2.00	0.10	0.15	0.35
R03SH189	0.10	0.15	0.10	1.10	4.70
R03SH270		0.15	0.19	0.15	

Location	Round 1	2	3	4	5
R03SH273		11.20		9.10	15.30
R03SH274		0.15	0.19	0.31	
R03SH275				0.30	
R03SH276		0.15		0.30	
R03SH277		4.30		1.00	
R03SH278				0.30	0.15
R03SH279				0.15	
R03SH280		5.70	0.10	0.30	53.20
R03SH281				0.15	
R03SH282		5.50	0.10	0.15	0.15
R03SH283		6.40		0.65	
R03SH284		0.15		2.90	1.00
R03SH285		0.15	0.10	0.30	
R03SH286		0.15	0.10	0.30	8.80

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.10	0.10	0.10	
2	24	0.15	249.00	12.38	50.47
3	9	0.10	0.19	0.12	0.04
4	29	0.15	9.10	0.82	1.69
5	16	0.15	53.20	7.68	14.72

Notes:

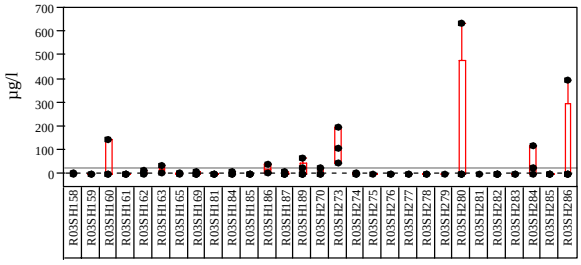
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

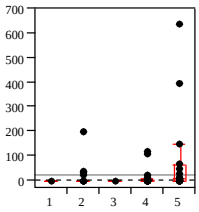
chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK

COPPER



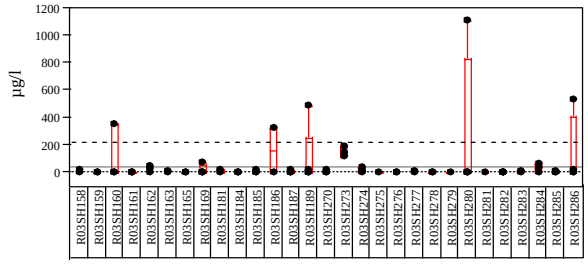


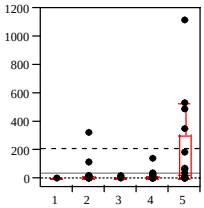
Location	Round 1	2	3	4	5
R03SH158		0.50		5.95	
R03SH159				1.25	2.20
R03SH160		0.50		2.70	150.00
R03SH161		0.50		1.65	0.55
R03SH162		0.50		15.20	9.70
R03SH163		36.70		5.95	
R03SH165		0.50		5.80	
R03SH169		0.50	0.36	3.45	14.20
R03SH181		0.50		1.80	1.45
R03SH184		0.50		12.20	1.35
R03SH185		0.50		1.20	2.90
R03SH186		42.50		5.25	
R03SH187		0.50	0.36	1.20	10.90
R03SH189	0.40	0.50	0.36	26.20	70.50
R03SH270		27.50	0.70	4.60	

Location	Round 1	2	3	4	5
R03SH273		200.00		111.00	49.00
R03SH274		0.50	0.70	7.65	
R03SH275				4.15	
R03SH276		2.00		2.35	
R03SH277		0.50		2.30	
R03SH278				1.45	0.55
R03SH279				2.85	
R03SH280		0.50	0.36	2.75	640.00
R03SH281				4.00	
R03SH282		0.50	0.36	1.10	1.90
R03SH283		0.50		2.20	
R03SH284		0.50		122.00	27.90
R03SH285		0.50	0.36	2.45	
R03SH286		0.50	0.36	1.70	398.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.40	0.40	0.40	
2	24	0.50	200.00	13.26	41.55
3	9	0.36	0.70	0.43	0.15
4	29	1.10	122.00	12.49	29.31
5	16	0.55	640.00	86.32	178.86

LEAD





Location	Round 1	2	3	4	5
R03SH158		2.40		12.90	
R03SH159				2.70	1.60
R03SH160		0.50		1.15	351.00
R03SH161		0.50		1.70	1.40
R03SH162		0.50		28.00	40.20
R03SH163		7.90		1.20	
R03SH165		0.50		0.85	
R03SH169		2.00	0.35	0.85	73.30
R03SH181		15.40		4.40	2.60
R03SH184		0.50		0.65	1.80
R03SH185		0.50		20.00	2.85
R03SH186		324.00		0.70	
R03SH187		0.50	0.35	0.85	13.30
R03SH189	0.75	0.50	0.35	14.75	487.00
R03SH270		21.30	0.70	0.85	

Location	Round 1	2	3	4	5
R03SH273		117.00		143.00	186.00
R03SH274		10.70	0.70	33.90	
R03SH275				1.70	
R03SH276		3.40		1.70	
R03SH277		1.30		4.10	
R03SH278				1.70	1.15
R03SH279				0.85	
R03SH280		2.40	0.35	0.85	1,110.00
R03SH281				0.85	
R03SH282		1.40	0.35	0.85	1.10
R03SH283		2.60		4.70	
R03SH284		0.50		33.00	65.50
R03SH285		0.50	10.40	1.40	
R03SH286		0.50	16.50	1.70	532.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.75	0.75	0.75	
2	24	0.50	324.00	21.55	68.66
3	9	0.35	16.50	3.34	5.94
4	29	0.65	143.00	11.10	27.24
5	16	1.10	1,110.00	179.43	306.21

Notes:

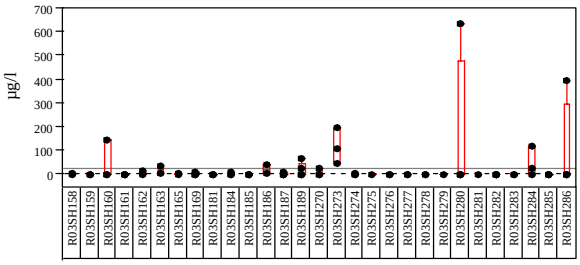
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

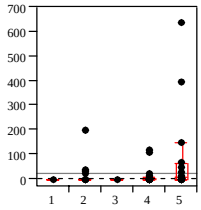
chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK

COPPER



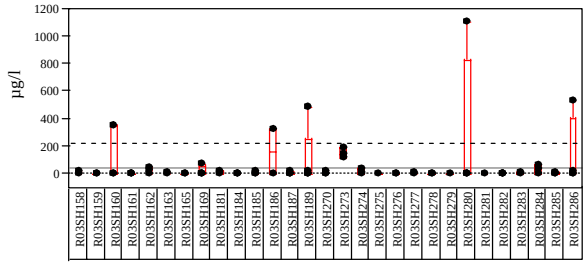


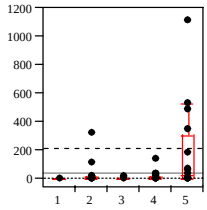
Location	Round 1	2	3	4	5
R03SH158		0.50		5.95	
R03SH159				1.25	2.20
R03SH160		0.50		2.70	150.00
R03SH161		0.50		1.65	0.55
R03SH162		0.50		15.20	9.70
R03SH163		36.70		5.95	
R03SH165		0.50		5.80	
R03SH169		0.50	0.36	3.45	14.20
R03SH181		0.50		1.80	1.45
R03SH184		0.50		12.20	1.35
R03SH185		0.50		1.20	2.90
R03SH186		42.50		5.25	
R03SH187		0.50	0.36	1.20	10.90
R03SH189	0.40	0.50	0.36	26.20	70.50
R03SH270		27.50	0.70	4.60	

Location	Round 1	2	3	4	5
R03SH273		200.00		111.00	49.00
R03SH274		0.50	0.70	7.65	
R03SH275				4.15	
R03SH276		2.00		2.35	
R03SH277		0.50		2.30	
R03SH278				1.45	0.55
R03SH279				2.85	
R03SH280		0.50	0.36	2.75	640.00
R03SH281				4.00	
R03SH282		0.50	0.36	1.10	1.90
R03SH283		0.50		2.20	
R03SH284		0.50		122.00	27.90
R03SH285		0.50	0.36	2.45	
R03SH286		0.50	0.36	1.70	398.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.40	0.40	0.40	
2	24	0.50	200.00	13.26	41.55
3	9	0.36	0.70	0.43	0.15
4	29	1.10	122.00	12.49	29.31
5	16	0.55	640.00	86.32	178.86

LEAD





Location	Round 1	2	3	4	5
R03SH158		2.40		12.90	
R03SH159				2.70	1.60
R03SH160		0.50		1.15	351.00
R03SH161		0.50		1.70	1.40
R03SH162		0.50		28.00	40.20
R03SH163		7.90		1.20	
R03SH165		0.50		0.85	
R03SH169		2.00	0.35	0.85	73.30
R03SH181		15.40		4.40	2.60
R03SH184		0.50		0.65	1.80
R03SH185		0.50		20.00	2.85
R03SH186		324.00		0.70	
R03SH187		0.50	0.35	0.85	13.30
R03SH189	0.75	0.50	0.35	14.75	487.00
R03SH270		21.30	0.70	0.85	

Location	Round 1	2	3	4	5
R03SH273		117.00		143.00	186.00
R03SH274		10.70	0.70	33.90	
R03SH275				1.70	
R03SH276		3.40		1.70	
R03SH277		1.30		4.10	
R03SH278				1.70	1.15
R03SH279				0.85	
R03SH280		2.40	0.35	0.85	1,110.00
R03SH281				0.85	
R03SH282		1.40	0.35	0.85	1.10
R03SH283		2.60		4.70	
R03SH284		0.50		33.00	65.50
R03SH285		0.50	10.40	1.40	
R03SH286		0.50	16.50	1.70	532.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.75	0.75	0.75	
2	24	0.50	324.00	21.55	68.66
3	9	0.35	16.50	3.34	5.94
4	29	0.65	143.00	11.10	27.24
5	16	1.10	1,110.00	179.43	306.21

Notes:

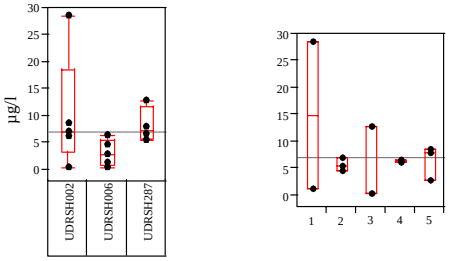
n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

NICHOLS CREEK REFERENCE AREA

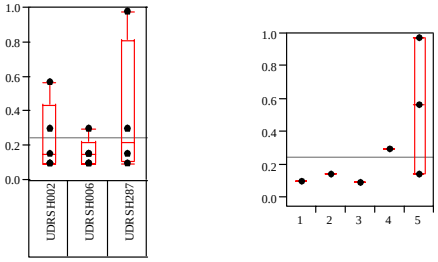
ARSENIC



Location	Round 1	2	3	4	5
UDRSH002	28.60	7.20	0.48	6.30	8.70
UDRSH006	1.40	4.60	0.48	6.40	2.90
UDRSH287		5.60	13.00	6.60	8.00

Round	Summary Statistics n	min	max	mean	S.D.
1	2	1.40	28.60	15.00	19.23
2	3	4.60	7.20	5.80	1.31
3	3	0.48	13.00	4.65	7.23
4	3	6.30	6.60	6.43	0.15
5	3	2.90	8.70	6.53	3.17

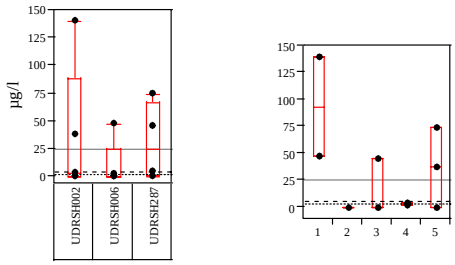
CADMIUM



Location	Round 1	2	3	4	5
UDRSH002	0.10	0.15	0.10	0.30	0.57
UDRSH006	0.10	0.15	0.10	0.30	0.15
UDRSH287		0.15	0.10	0.30	0.98

Round	Summary Statistics n	min	max	mean	S.D.
1	2	0.10	0.10	0.10	
2	3	0.15	0.15	0.15	
3	3	0.10	0.10	0.10	
4	3	0.30	0.30	0.30	
5	3	0.15	0.98	0.57	0.42

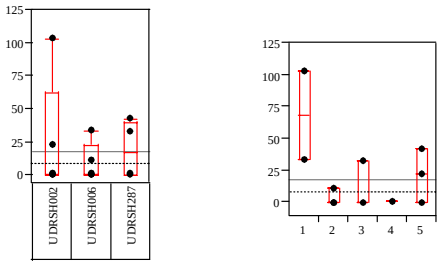
COPPER



Location	Round 1	2	3	4	5
UDRSH002	140.00	0.50	0.36	3.65	38.20
UDRSH006	47.40	0.50	0.36	2.15	0.55
UDRSH287		0.50	45.60	4.25	74.40

Round	Summary Statistics n	min	max	mean	S.D.
1	2	47.40	140.00	93.70	65.48
2	3	0.50	0.50	0.50	
3	3	0.36	45.60	15.44	26.12
4	3	2.15	4.25	3.35	1.08
5	3	0.55	74.40	37.72	36.93

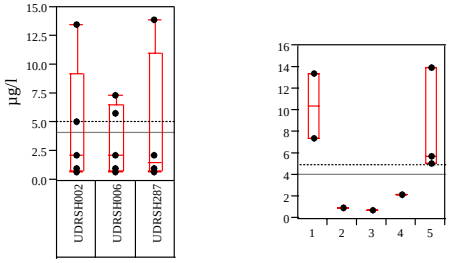
LEAD



Location	Round 1	2	3	4	5
UDRSH002	103.00	0.50	0.35	1.70	23.20
UDRSH006	33.70	11.60	0.35	1.70	0.55
UDRSH287		0.50	32.80	1.70	42.60

Round	Summary Statistics n	min	max	mean	S.D.
1	2	33.70	103.00	68.35	49.00
2	3	0.50	11.60	4.20	6.41
3	3	0.35	32.80	11.16	18.74
4	3	1.70	1.70	1.70	
5	3	0.55	42.60	22.12	21.05

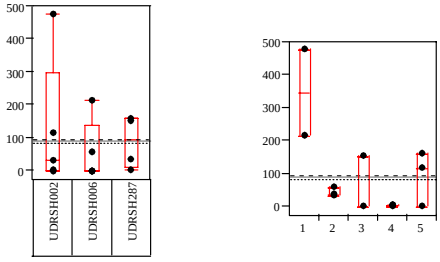
SELENIUM



Location	Round 1	2	3	4	5
UDRSH002	13.50	1.00	0.75	2.20	5.10
UDRSH006	7.40	1.00	0.75	2.20	5.80
UDRSH287		1.00	0.75	2.20	14.00

Round	Summary Statistics n	min	max	mean	S.D.
1	2	7.40	13.50	10.45	4.31
2	3	1.00	1.00	1.00	
3	3	0.75	0.75	0.75	
4	3	2.20	2.20	2.20	
5	3	5.10	14.00	8.30	4.95

ZINC



Location	Round 1	2	3	4	5
UDRSH002	479.00	32.20	0.15	2.45	118.00
UDRSH006	217.00	58.00	0.15	1.90	2.10
UDRSH287		37.90	155.00	3.60	161.00

Round	Summary Statistics n	min	max	mean	S.D.
1	2	217.00	479.00	348.00	185.26
2	3	32.20	58.00	42.70	13.55
3	3	0.15	155.00	51.77	89.40
4	3	1.90	3.60	2.65	0.87
5	3	2.10	161.00	93.70	82.19

Notes:

n number of locations
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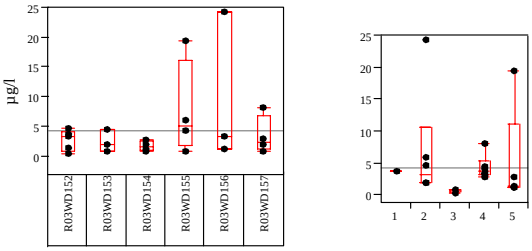
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 3 POND

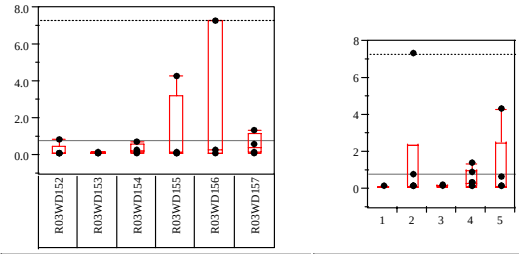
ARSENIC



Location	Round 1	2	3	4	5
R03WD152	3.80	4.70	0.48	3.50	1.45
R03WD153		2.00	0.95	4.60	
R03WD154		2.00	0.95	2.90	1.35
R03WD155		6.10	0.95	4.30	19.60
R03WD156		24.40		3.50	1.35
R03WD157		2.00	0.95	8.20	3.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	3.80	3.80	3.80	
2	6	2.00	24.40	6.87	8.76
3	5	0.48	0.95	0.86	0.21
4	6	2.90	8.20	4.50	1.91
5	5	1.35	19.60	5.35	8.00

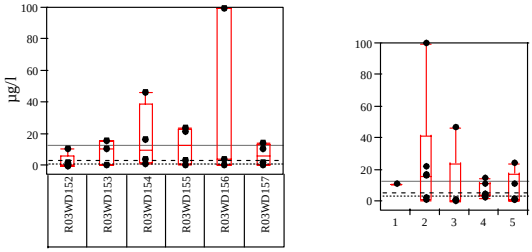
CADMIUM



Location	Round 1	2	3	4	5
R03WD152	0.10	0.15	0.10	0.85	0.15
R03WD153		0.15	0.19	0.15	
R03WD154		0.74	0.19	0.30	0.15
R03WD155		0.15	0.19	0.15	4.30
R03WD156		7.30		0.30	0.15
R03WD157		0.15	0.19	1.40	0.65

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.10	0.10	0.10	
2	6	0.15	7.30	1.44	2.88
3	5	0.10	0.19	0.17	0.04
4	6	0.15	1.40	0.53	0.50
5	5	0.15	4.30	1.08	1.81

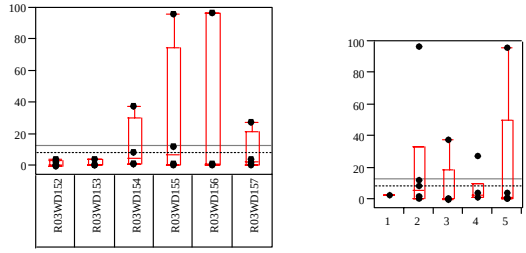
COPPER



Location	Round 1	2	3	4	5
R03WD152	11.10	0.50	0.36	2.30	1.10
R03WD153		15.80	0.70	11.10	
R03WD154		16.70	47.00	4.45	1.60
R03WD155		22.10	0.70	3.90	24.00
R03WD156		99.80		4.40	0.70
R03WD157		2.00	0.70	14.90	11.10

Round	Summary Statistics n	min	max	mean	S.D.
1	1	11.10	11.10	11.10	
2	6	0.50	99.80	26.15	37.09
3	5	0.36	47.00	9.89	20.75
4	6	2.30	14.90	6.84	4.98
5	5	0.70	24.00	7.70	10.09

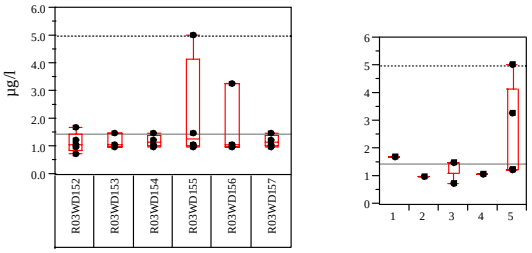
LEAD



Location	Round 1	2	3	4	5
R03WD152	3.30	0.50	0.35	4.70	0.85
R03WD153		0.50	0.70	4.20	
R03WD154		9.00	37.80	1.70	1.40
R03WD155		12.80	0.70	1.70	96.20
R03WD156		97.20		1.90	0.85
R03WD157		2.50	0.70	27.70	4.25

Round	Summary Statistics n	min	max	mean	S.D.
1	1	3.30	3.30	3.30	
2	6	0.50	97.20	20.42	37.94
3	5	0.35	37.80	8.05	16.63
4	6	1.70	27.70	6.98	10.24
5	5	0.85	96.20	20.71	42.22

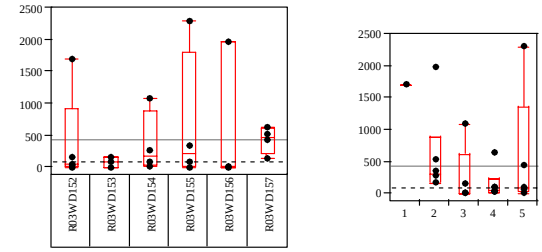
SELENIUM



Location	Round 1	2	3	4	5
R03WD152	1.70	1.00	0.75	1.10	1.25
R03WD153		1.00	1.50	1.10	
R03WD154		1.00	1.50	1.10	1.25
R03WD155		1.00	1.50	1.10	5.05
R03WD156		1.00		1.10	3.30
R03WD157		1.00	1.50	1.10	1.25

Round	Summary Statistics n	min	max	mean	S.D.
1	1	1.70	1.70	1.70	
2	6	1.00	1.00	1.00	0.00
3	5	0.75	1.50	1.35	0.34
4	6	1.10	1.10	1.10	0.00
5	5	1.25	5.05	2.42	1.72

ZINC



Location	Round 1	2	3	4	5
R03WD152	1,700.00	167.00	0.15	46.00	55.30
R03WD153		177.00	0.30	92.50	
R03WD154		288.00	1,100.00	25.45	103.00
R03WD155		357.00	0.30	102.00	2,300.00
R03WD156		1,970.00		31.00	16.65
R03WD157		532.00	161.00	643.00	433.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	1,700.00	1,700.00	1,700.00	
2	6	167.00	1,970.00	581.83	693.16
3	5	0.15	1,100.00	252.35	478.94
4	6	25.45	643.00	156.66	240.37
5	5	16.65	2,300.00	581.59	974.70

Notes:

n number of locations
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max maximum concentration
S.D. standard deviation of arithmetic mean
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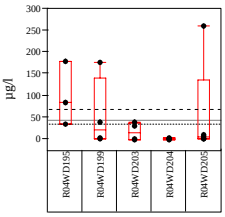
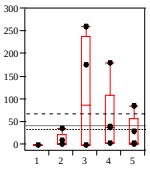
chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G3 (Continued)
SUMMARY OF TOTAL SURFACE-WATER METAL CONCENTRATIONS IN EACH AQUATIC HABITAT DURING MONITORING YEARS ONE THROUGH FIVE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

RASS 4 WETLAND

ARSENIC

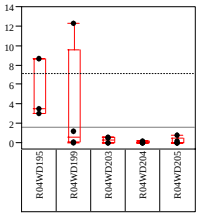


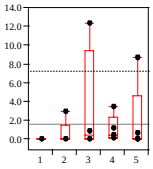


Location	Round 1	2	3	4	5
R04WD195		36.90		181.00	86.00
R04WD199		2.00	177.00	39.80	4.60
R04WD203		2.00	0.48	41.40	31.40
R04WD204		2.00	0.48	5.10	2.60
R04WD205	1.40	12.10	261.00	5.50	2.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	1.40	1.40	1.40	
2	5	2.00	36.90	11.00	15.12
3	4	0.48	261.00	109.74	130.74
4	5	5.10	181.00	54.56	72.85
5	5	2.00	86.00	25.32	36.08

CADMIUM

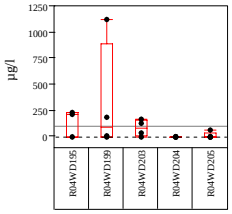


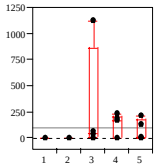


Location	Round 1	2	3	4	5
R04WD195		3.10		3.60	8.80
R04WD199		0.15	12.40	1.30	0.17
R04WD203		0.15	0.10	0.57	0.75
R04WD204		0.15	0.10	0.30	0.15
R04WD205	0.10	0.15	0.95	0.30	0.15

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.10	0.10	0.10	
2	5	0.15	3.10	0.74	1.32
3	4	0.10	12.40	3.39	6.02
4	5	0.30	3.60	1.21	1.40
5	5	0.15	8.80	2.00	3.81

COPPER

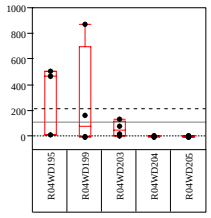


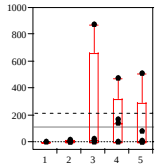


Location	Round 1	2	3	4	5
R04WD195		0.50		233.00	217.00
R04WD199		0.50	1,130.00	189.00	10.50
R04WD203		0.50	38.00	169.00	137.00
R04WD204		0.50	0.36	4.55	4.00
R04WD205	0.40	0.50	69.60	2.75	3.20

Round	Summary Statistics n	min	max	mean	S.D.
1	1	0.40	0.40	0.40	
2	5	0.50	0.50	0.50	0.00
3	4	0.36	1,130.00	309.49	547.74
4	5	2.75	233.00	119.66	108.41
5	5	3.20	217.00	74.34	97.93

LEAD

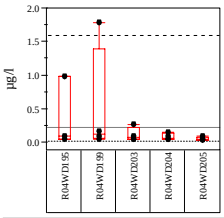


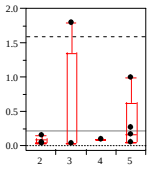


Location	Round 1	2	3	4	5
R04WD195		12.80		476.00	510.00
R04WD199		0.50	876.00	171.00	2.85
R04WD203		6.50	21.00	137.00	82.60
R04WD204		7.00	7.60	2.30	3.10
R04WD205	2.00	2.70	3.45	1.70	5.00

Round	Summary Statistics n	min	max	mean	S.D.
1	1	2.00	2.00	2.00	
2	5	0.50	12.80	5.90	4.71
3	4	3.45	876.00	227.01	432.72
4	5	1.70	476.00	157.60	193.91
5	5	2.85	510.00	120.71	220.29

MERCURY

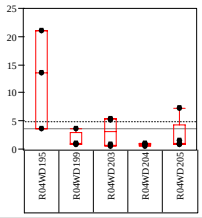


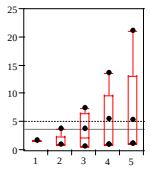


Location	Round 1	2	3	4	5
R04WD195		0.06		0.10	1.00
R04WD199		0.07	1.80	0.10	0.18
R04WD203		0.07	0.06	0.10	0.28
R04WD204		0.16	0.06	0.10	0.06
R04WD205		0.05	0.06	0.10	0.06

Round	Summary Statistics n	min	max	mean	S.D.
2	5	0.05	0.16	0.08	0.05
3	4	0.06	1.80	0.49	0.87
4	5	0.10	0.10	0.10	0.00
5	5	0.06	1.00	0.32	0.39

SELENIUM

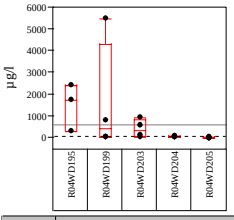


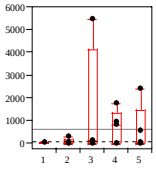


Location	Round 1	2	3	4	5
R04WD195		3.80		13.80	21.10
R04WD199		1.00	3.75	1.10	1.25
R04WD203		1.00	0.75	5.50	5.45
R04WD204		1.00	0.75	1.10	1.25
R04WD205	1.70	1.00	7.50	1.10	1.25

Round	Summary Statistics n	min	max	mean	S.D.
1	1	1.70	1.70	1.70	
2	5	1.00	3.80	1.56	1.25
3	4	0.75	7.50	3.19	3.20
4	5	1.10	13.80	4.52	5.53
5	5	1.25	21.10	6.06	8.60

ZINC





Location	Round 1	2	3	4	5
R04WD195		298.00		1,760.00	2,430.00
R04WD199		43.70	5,500.00	827.00	51.00
R04WD203		52.00	153.00	943.00	570.00
R04WD204		63.50	98.30	21.80	25.60
R04WD205	37.50	0.50	0.15	6.95	17.30

Round	Summary Statistics n	min	max	mean	S.D.
1	1	37.50	37.50	37.50	
2	5	0.50	298.00	91.54	117.85
3	4	0.15	5,500.00	1,437.86	2,708.83
4	5	6.95	1,760.00	711.75	731.16
5	5	17.30	2,430.00	618.78	1,039.10

Notes:

n number of locations
min minimum concentration
max maximum concentration
S.D. standard deviation of arithmetic mean
round individual monitoring year

chronic benchmark
acute benchmark
grand mean for locations or rounds

ATTACHMENT G4

DOSE CALCULATIONS FOR BIRDS AND MAMMALS

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TABLE G4-1

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE BLACK RAIL (AMPHIPOD DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[amphipods] (mg/kg)[d]	$IR_{amphipods}$ (kg/day)[e]	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Ditches	1/2 DL	0.006	0.25	0.006	0.04	0.001	1	0.03	0.05	0.003	0.74		X	
PCBs/Aroclors	Ditches	1/2 DL	0.006	3.71	0.006	1.12	0.001	1	0.03	0.78	0.04	0.65			X
Total DDTs	Ditches	Full DL	0.006	0.50	0.006	0.08	0.001	1	0.03	0.10	0.003	0.74		X	
PCBs/Aroclors	Ditches	Full DL	0.006	7.42	0.006	2.24	0.001	1	0.03	1.56	0.04	0.65			X

Notes:

a Data from the ditches (Units 5 and 7) were used in the dose model.
b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.
c IR_{prey} calculated using Nagy and others (1999) equation for all birds.
d Amphipod concentrations are based on BAFs for Aroclor-1254 and 4,4'-DDT presented in EPA 1999.
e $IR_{amphipods}$ is 100 percent of IR_{prey}.
f Maximum concentration in ditch sediment.
g $IR_{sediment}$ is 18 percent of IR_{prey}.
h Body weights are from Eddleman and others (1994).

BAF Bioaccumulation factor
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: Eddleman, W.R., R.E. Flores, and M.L. Legare. 1994. "Black Rail." *The Birds of North America* . Volume 123. Pages 1 through 20.
EPA 1999. "Screening-level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-1 (Continued)

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE BLACK RAIL (CLAM DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[clams] (mg/kg)[d]	IR_{clams} (kg/day)[e]	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Ditches	1/2 DL	0.006	0.03	0.006	0.04	0.001	1	0.03	0.01	0.003	0.74		X	
PCBs/Aroclors	Ditches	1/2 DL	0.006	0.05	0.006	1.12	0.001	1	0.03	0.05	0.04	0.65		X	
Total DDTs	Ditches	Full DL	0.006	0.10	0.006	0.08	0.001	1	0.03	0.02	0.003	0.74		X	
PCBs/Aroclors	Ditches	Full DL	0.006	0.22	0.006	2.24	0.001	1	0.03	0.12	0.04	0.65		X	

Notes:

a Data from the ditches (Units 5 and 7) were used in the dose model.

b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.

c IR_{prey} calculated using Nagy and others (1999) equation for all birds.

d Clam concentrations are the maximum in dry weight clam samples from the Litigation Area; total concentrations were calculated using 1/2 DL or Full DL as a substitute for nondetects, as described in note b.

e IR_{clam} is 100 percent of IR_{prey}.

f Maximum concentration in ditch sediment in dry weight.

g $IR_{sediment}$ is 18 percent of IR_{prey}.

h Body weights are from Eddleman and others (1994).

DDT Dichlorodiphenyltrichloroethane
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: Eddleman, W.R., R.E. Flores, and M.L. Legare. 1994. "Black Rail." *The Birds of North America* . Volume 123. Pages 1 through 20.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-2

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE MALLARD (SLOUGH DOSE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[amphipods] (mg/kg)[d]	$IR_{amphipods}$ (kg/day)[e]	[fish] (mg/kg)[f]	IR_{fish} (kg/day)[g]	[sediment] (mg/kg)[h]	$IR_{sediment}$ (kg/day)[i]	SUF	Body Weight (kg)[j]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Slough	1/2 DL	0.09	0.21	0.07	0.06	0.02	0.04	0.003	1	1.16	0.01	0.01	1.55		X	
PCBs/Aroclors	Slough	1/2 DL	0.09	3.18	0.07	0.08	0.02	0.96	0.003	1	1.16	0.19	0.10	1.17		X	
Total DDTs	Slough	Full DL	0.09	0.43	0.07	0.06	0.02	0.07	0.003	1	1.16	0.03	0.01	1.55		X	
PCBs/Aroclors	Slough	Full DL	0.09	6.36	0.07	0.11	0.02	1.92	0.003	1	1.16	0.38	0.10	1.17		X	

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.
b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.
c IR_{prey} calculated using Nagy and others (1999) equation for all birds.
d Amphipod tissue concentrations were calculated using a sediment to benthic invertebrate BAF presented in EPA 1999.
e $IR_{amphipods}$ is 75 percent of IR_{prey}.
f Fish concentrations are from 1995 slough fish samples; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.
g IR_{fish} is 25 percent of IR_{prey}.
h Maximum sediment concentrations were used in the doses; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.
i $IR_{sediment}$ is 3.3 percent of IR_{prey}.
j Body weight is an average from EPA (1993).

BAF Bioaccumulation factor
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.
EPA. 1999. "Screening-level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds."*Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-2 (Continued)

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE MALLARD (POND DOSE)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Prey 3		Prey 4		Sediment					TRV				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[damselfly larvae] (mg/kg)[d]	IR_{larvae} (kg/day)[e]	[fish] (mg/kg)[f]	IR_{fish} (kg/day)[g]	[tadpoles] (mg/kg)[h]	$IR_{tadpoles}$ (kg/day)[i]	[plants] (mg/kg)[j]	IR_{plants} (kg/day)[k]	[sediment] (mg/kg)[l]	$IR_{sediment}$ (kg/day)[m]	SUF	Body Weight (kg)[n]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Pond	1/2 DL	0.09	0.16	0.05	0.06	0.01	0.01	0.01	0.0004	0.02	0.01	0.003	1	1.16	0.01	0.01	1.55	X		
PCBs/Aroclors	Pond	1/2 DL	0.09	0.43	0.05	0.14	0.01	0.08	0.01	0.001	0.02	0.35	0.003	1	1.16	0.02	0.10	1.17	X		
Total DDTs	Pond	Full DL	0.09	0.26	0.05	0.06	0.01	0.03	0.01	0.01	0.02	0.03	0.003	1	1.16	0.01	0.01	1.55		X	
PCBs/Aroclors	Pond	Full DL	0.09	0.78	0.05	0.15	0.01	0.16	0.01	0.02	0.02	0.70	0.003	1	1.16	0.04	0.10	1.17	X		

Notes:

a Data from the pond (Unit 13) were used in the dose model.
b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.
c IR_{prey} calculated using Nagy and others (1999) equation for all birds.
d Damselfly tissue concentrations are the maximum from 1995 Litigation Area data.
e IR_{larvae} is 50 percent of IR_{prey}.
f Fish concentrations are from 1995 pond fish samples; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.
g IR_{fish} is 12.5 percent of IR_{prey}.
h Tadpole concentrations are from 1995 pond tadpole samples; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.
i $IR_{tadpole}$ is 12.5 percent of IR_{prey}.
j Plant tissue concentrations were calculated using a sediment to plant BAF from EPA 1999.
k IR_{plants} is 25 percent of IR_{prey}.
l Maximum sediment concentrations were used in the doses; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.
m $IR_{sediment}$ is 3.3 percent of the IR_{prey}.
n Body weight is an average from EPA (1993).

BAF Bioaccumulation factor
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.
EPA. 1999. "Screening-level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

TABLE G4-3

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE GREAT BLUE HERON (SLOUGH DOSES)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[fish] (mg/kg)[d]	IR_{fish} (kg/day)[e]	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Slough	1/2 DL	0.13	0.06	0.13	0.04	0.004	1	2.39	0.003	0.01	1.79	X		
PCBs/Aroclors	Slough	1/2 DL	0.13	0.08	0.13	0.96	0.004	1	2.39	0.006	0.11	1.36	X		
Total DDTs	Slough	Full DL	0.13	0.06	0.13	0.07	0.004	1	2.39	0.003	0.01	1.79	X		
PCBs/Aroclors	Slough	Full DL	0.13	0.11	0.13	1.92	0.004	1	2.39	0.010	0.11	1.36	X		

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.

b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.

c IR_{prey} calculated using Nagy and others (1999) equation for fish-eating birds.

d Fish concentrations are maximums from sculpin samples collected in 1996; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.

e IR_{fish} is 100 percent of the IR_{prey}.

f Maximum concentration in slough sediment; total concentrations were calcualted using 1/2DL and Full DL as a substitute for nondetects, as described in note b.

g $IR_{sediment}$ is 3.3 percent of the IR_{prey}.

h Body weight from Dunning 1993.

DDT Dichlorodiphenyltrichloroethane
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-3 (Continued)

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE GREAT BLUE HERON (POND DOSES)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Prey 3		Sediment					TRVs (k)				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[fish] (mg/kg)[d]	IR_{fish} (kg/day)[e]	[crayfish] (mg/kg)[f]	$IR_{crayfish}$ (kg/day)[g]	[tadpoles] (mg/kg)[h]	$IR_{tadpoles}$ (kg/day)[i]	[sediment] (mg/kg)[j]	$IR_{sediment}$ (kg/day)[k]	SUF	Body Weight (kg)[l]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Pond	1/2 DL	0.13	0.06	0.10	0.26	0.02	0.01	0.01	0.04	0.004	0.5	2.39	0.002	0.01	1.79	X		
PCBs/Aroclors	Pond	1/2 DL	0.13	0.14	0.10	0.71	0.02	0.08	0.01	0.96	0.004	0.5	2.39	0.006	0.11	1.36	X		
Total DDTs	Pond	Full DL	0.13	0.06	0.10	0.40	0.02	0.03	0.01	0.07	0.004	0.5	2.39	0.003	0.01	1.79	X		
PCBs/Aroclors	Pond	Full DL	0.13	0.15	0.10	1.17	0.02	0.16	0.01	1.92	0.004	0.5	2.39	0.008	0.11	1.36	X		

Notes:

a Data from the pond (Unit 13) were used in the dose model.

b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.

c IR_{prey} calculated using Nagy and others (1999) equation for fish-eating birds.

d Fish tissue concentrations are maximums from stickleback samples collected in 1996; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.

e IR_{fish} is 80 percent of IR_{prey}.

f Crayfish tissue concentrations are based on one crayfish sample collected in 1996; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.

g $IR_{crayfish}$ is 15 percent of IR_{prey}.

h Tadpole tissue concentrations are based on one crayfish sample collected in 1996; total concentrations were calculated using 1/2 DL and Full DL as a substitute for nondetects, as described in note b.

i $IR_{tadpole}$ is 5 percent of IR_{prey}.

j Maximum concentration in pond sediment.

k $IR_{sediment}$ is 3.3 percent of the IR for prey.

l Body weight from Dunning 1993.

DDT Dichlorodiphenyltrichloroethane
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-4

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE NORTHERN HARRIER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Soil					TRVs				
Analyte	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[Rodent tissue] (mg/kg)[d]	IR_{rodent} (kg/day)[e]	[soil] (mg/kg)[f]	IR_{soil} (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	RASS 3 and 4 Upland	1/2 DL	0.04	0.00001	0.03	0.04	0.0003	1.00	0.44	0.00002	0.01	1.27	X		
PCBs/Aroclors	RASS 3 and 4 Upland	1/2 DL	0.04	0.0004	0.03	1.63	0.0003	1.00	0.44	0.001	0.07	1.13	X		
Total DDTs	RASS 3 and 4 Upland	Full DL	0.04	0.00001	0.03	0.04	0.0003	1.00	0.44	0.00002	0.01	1.27	X		
PCBs/Aroclors	RASS 3 and 4 Upland	Full DL	0.04	0.0004	0.03	1.76	0.0003	1.00	0.44	0.001	0.07	1.13	X		

Notes:

a Data from the RASS 3 and 4 upland habitat (Units 14 and 16) were used in the dose model.

b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.

c IR_{prey} calculated using Nagy and others (1999) equation for all birds.

d Rodent tissue concentrations were calculated using a sediment to plant BAF from EPA 1999.

e IR_{rodent} is 100 percent of IR_{prey}.

f Maximum concentration in RASS 3 and 4 uplands.

g IR_{soil} is 0.7 percent of IR_{prey}.

f Body weight from Dunning (1993).

BAF Bioaccumulation factor
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
RASS Remedial action subsite
SUF Site use factor
TRV Toxicity reference value

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
EPA. 1999. "Screening-level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition*. Volume 19. Pages 247-277.

TABLE G4-5

INORGANIC CHEMICAL DOSES FOR THE BLACK RAIL (AMPHIPOD DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1			Sediment						TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[amphipods] (mg/kg)[d]	$IR_{amphipod}$ (kg/day)[e]	Prey Daily Dose[f]	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	Sediment Daily Dose (g)	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Main Slough	Maximum	0.006	8.27	0.006	0.048	288.48	0.001	0.30	1	0.03	12.00	2.62	10.50			X
Cadmium	Main Slough	Maximum	0.006	1.35	0.006	0.008	243.80	0.001	0.25	1	0.03	9.01	0.04	8.43			X
Copper	Main Slough	Maximum	0.006	187.22	0.006	1.082	431.25	0.001	0.45	1	0.03	52.79	1.24	30.78			X
Lead	Main Slough	Maximum	0.006	6.24	0.006	0.036	144.68	0.001	0.15	1	0.03	6.43	0.01	4.51			X
Mercury*	Main Slough	Maximum	0.006	0.15	0.006	0.001	0.87	0.001	0.001	1	0.03	0.06	0.02	0.09		X	
Selenium*	Main Slough	Maximum	0.006	0.64	0.006	0.004	4.25	0.001	0.004	1	0.03	0.28	0.11	0.45		X	
Zinc	Main Slough	Maximum	0.006	388.72	0.006	2.247	28,080.00	0.001	29.21	1	0.03	1,084.87	8.55	85.51			X

Notes:

a Data from the main slough (Units 9, 10, and 11) were used in the dose model.
b Maximum doses calculated using 99th percentile sediment concentration and maximum tissue concentration with exposure parameters for a typical receptor.
c IR_{prey} calculated using Nagy and others (1999) equation for all birds.
d Amphipod concentrations are maximums from 1996 site-collected tissue data.
e $IR_{amphopod}$ is 100 percent of IR_{prey}.
f 99th percentile concentration in main slough sediment.
g $IR_{sediment}$ is 18 percent of IR_{prey}.
h Body weight is from Eddleman and others (1994).
* Mercury and selenium were not detected in amphipod tissue; one-half the detection limit was used in the dose.

IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
SUF Site use factor
TRV Toxicity reference value

Source: Eddleman, W.R., R.E. Flores, and M.L. Legare. 1994. "Black Rail." *The Birds of North America* . Volume 123. Pages 1-20.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds.' *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-6

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE SUISUN SONG SPARROW (AMPHIPOD DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1							TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[amphipod] (mg/kg)[d]	$IR_{amphipod}$ (kg/day)[e]	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Slough	UCL_{95}	0.005	8.27	0.005	135.70	0.0004	1	0.02	3.91	2.52	10.07		X	
	Slough	Mean	0.005	6.31	0.005	101.20	0.0004	1	0.02	2.94	2.52	10.07		X	
Cadmium	Slough	UCL_{95}	0.005	1.35	0.005	2.00	0.0004	1	0.02	0.31	0.04	8.08		X	
	Slough	Mean	0.005	1.20	0.005	1.58	0.0004	1	0.02	0.27	0.04	8.08		X	
Copper	Slough	UCL_{95}	0.005	187.22	0.005	181.89	0.0004	1	0.02	41.21	1.19	29.51			X
	Slough	Mean	0.005	169.85	0.005	153.61	0.0004	1	0.02	37.20	1.19	29.51			X
Lead	Slough	UCL_{95}	0.005	6.24	0.005	131.06	0.0004	1	0.02	3.42	0.01	4.32		X	
	Slough	Mean	0.005	1.12	0.005	104.93	0.0004	1	0.02	1.94	0.01	4.32		X	
Mercury	Slough	UCL_{95}	0.005	0.15	0.005	0.36	0.0004	1	0.02	0.04	0.02	0.09		X	
	Slough	Mean	0.005	0.11	0.005	0.29	0.0004	1	0.02	0.03	0.02	0.09		X	
Selenium	Slough	UCL_{95}	0.005	0.64	0.005	1.64	0.0004	1	0.02	0.16	0.11	0.43		X	
	Slough	Mean	0.005	0.54	0.005	1.44	0.0004	1	0.02	0.13	0.11	0.43		X	
Zinc	Slough	UCL_{95}	0.005	388.72	0.005	715.25	0.0004	1	0.02	91.09	8.20	81.99			X
	Slough	Mean	0.005	334.61	0.005	577.05	0.0004	1	0.02	77.77	8.20	81.99		X	

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.

b UCL_{95} dose calculated using UCL_{95} sediment and UCL_{95} or maximum tissue concentration with exposure parameters for a typical receptor.
Mean dose calculated using mean sediment concentration and mean tissue concentration with exposure parameters for a typical receptor.

c IR_{prey} calculated using Nagy and others (1999) equation for passerines.

d Amphipod concentrations are maximums from 1995 slough samples. For nondetected values, the detection limit was used in calculations.

e $IR_{amphipod}$ is 100 percent of the IR_{prey}.

f UCL_{95} sediment concentration in marsh surface sediment.

g $IR_{sediment}$ is 8 percent of the IR_{prey}.

h Body weight is from Dunning (1993).

IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95th percentile upper confidence level of the mean

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." Annual Review of Nutrition. Volume 19. Pages 247-277.

TABLE G4-6 (Continued)

INORGANIC CHEMICAL DOSE CALCUATIONS FOR THE SUISUN SONG SPARROW (AMPHIPOD PLANT DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Prey 3		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[amphipod] (mg/kg)[d]	$IR_{amphipod}$ (kg/day)[e]	[bulrush] (mg/kg)[f]	$IR_{bulrush}$ (kg/day)[g]	[pickleweed] (mg/kg)[h]	$IR_{pickleweed}$ (kg/day)[i]	[sediment] (mg/kg)[j]	$IR_{sediment}$ (kg/day)[k]	SUF	Body Weight (kg)[l]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Slough	UCL_{95}	0.005	8.27	0.002	92.99	0.001	0.10	0.001	135.70	0.0004	1	0.02	7.82	2.52	10.07		X	
	Slough	Mean	0.005	6.31	0.002	42.56	0.001	0.07	0.001	101.20	0.0004	1	0.02	4.47	2.52	10.07		X	
Cadmium	Slough	UCL_{95}	0.005	1.35	0.002	5.57	0.001	0.01	0.001	2.00	0.0004	1	0.02	0.46	0.04	8.08		X	
	Slough	Mean	0.005	1.20	0.002	4.63	0.001	0.01	0.001	1.58	0.0004	1	0.02	0.39	0.04	8.08		X	
Copper	Slough	UCL_{95}	0.005	187.22	0.002	27.33	0.001	1.15	0.001	181.89	0.0004	1	0.02	23.55	1.19	29.51		X	
	Slough	Mean	0.005	169.85	0.002	21.02	0.001	1.00	0.001	153.61	0.0004	1	0.02	20.98	1.19	29.51		X	
Lead	Slough	UCL_{95}	0.005	6.24	0.002	2.97	0.001	0.42	0.001	131.06	0.0004	1	0.02	2.95	0.01	4.32		X	
	Slough	Mean	0.005	1.12	0.002	2.08	0.001	0.23	0.001	104.93	0.0004	1	0.02	1.95	0.01	4.32		X	
Mercury*	Slough	UCL_{95}	0.005	0.15	0.002	0.004	0.001	0.004	0.001	0.36	0.0004	1	0.02	0.02	0.02	0.09		X	
	Slough	Mean	0.005	0.11	0.002	0.003	0.001	0.003	0.001	0.29	0.0004	1	0.02	0.02	0.02	0.09	X		
Selenium	Slough	UCL_{95}	0.005	0.64	0.002	28.44	0.001	0.09	0.001	1.64	0.0004	1	0.02	1.55	0.11	0.43			X
	Slough	Mean	0.005	0.54	0.002	19.53	0.001	0.08	0.001	1.44	0.0004	1	0.02	1.08	0.11	0.43			X
Zinc	Slough	UCL_{95}	0.005	388.72	0.002	87.04	0.001	7.13	0.001	715.25	0.0004	1	0.02	56.20	8.20	81.99		X	
	Slough	Mean	0.005	334.61	0.002	68.28	0.001	6.08	0.001	577.05	0.0004	1	0.02	47.40	8.20	81.99		X	

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.

b UCL_{95} dose calculated using UCL_{95} sediment and UCL_{95} or maximum tissue concentration with exposure parameters for a typical receptor.
Mean dose calculated using mean sediment concentration and mean tissue concentration with exposure parameters for a typical receptor.

c IR_{prey} calculated using Nagy and others (1999) equation for passerines.

d Amphipod concentrations are maximums from 1995 slough samples. For nondetected values, the detection limit was used in calculations.

e $IR_{amphipod}$ is 50 percent of IR_{prey}.

f Bulrush concentrations are maximums from 1991 plant tissue samples collected in RASS 1. Seed concentrations are assumed to be equal to plant concentrations.

g $IR_{bulrush}$ is 25 percent of IR_{prey}.

h Pickleweed concentrations are UCL_{95} concentrations from green tissue samples collected in 1991.

i $IR_{pickleweed}$ is 25 percent of IR_{prey}.

j UCL_{95} concentration from marsh surface sediment.

k $IR_{sediment}$ is 8 percent of the IR_{prey}.

l Body weight is from Dunning (1993).

* For mercury, pickleweed was used for 50 percent of the diet because bulrush were not analyzed for mercury.

IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
RASS Remedial action subsite
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence level of the mean

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." Annual Review of Nutrition. Volume 19. Pages 247-277.

TABLE G4-7

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE MALLARD (SLOUGH DOSES)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[amphipod] (mg/kg)[d]	$IR_{amphipod}$ (kg/day)[e]	[fish] (mg/kg)[f]	IR_{fish} (kg/day)[g]	[sediment] (mg/kg)[h]	$IR_{sediment}$ (kg/day)[i]	SUF	Body Weight (kg)[j]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Slough	UCL_{95}	0.09	8.27	0.07	1.30	0.02	76.88	0.003	1	1.16	0.72	5.49	21.97	X		
Cadmium	Slough	UCL_{95}	0.09	1.35	0.07	0.16	0.02	19.66	0.003	1	1.16	0.13	0.09	17.64		X	
Copper	Slough	UCL_{95}	0.09	187.22	0.07	23.95	0.02	130.94	0.003	1	1.16	11.90	2.59	64.39		X	
Lead	Slough	UCL_{95}	0.09	6.24	0.07	0.15	0.02	49.83	0.003	1	1.16	0.50	0.02	9.43		X	
Mercury	Slough	UCL_{95}	0.09	0.15	0.07	0.12	0.02	0.46	0.003	1	1.16	0.01	0.04	0.19	X		
Selenium	Slough	UCL_{95}	0.09	0.64	0.07	0.48	0.02	1.97	0.003	1	1.16	0.05	0.23	0.94	X		
Zinc	Slough	UCL_{95}	0.09	388.72	0.07	0.17	0.02	2,809.50	0.003	1	1.16	30.35	17.89	178.85		X	

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.
b The UCL_{95} for soil and tissue data were used in the dose.
c IR_{prey} calculated using Nagy and others (1999) equation for all birds.
d Maximum amphipod tissue concentrations were used in the dose.
e $IR_{amphipod}$ is 75 percent of the IR_{prey}.
f Maximum fish tissue concentrations were used in the dose.
g IR_{fish} is 25 percent of the IR_{prey}.
h UCL_{95} concentration in slough sediment.
i $IR_{sediment}$ is 3.3 percent of the IR_{prey}.
j Body weight is an average from EPA (1993).

EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
RASS Remedial action subsite
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence level of the mean

Source: EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.

TABLE G4-7 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE MALLARD (POND DOSES)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Prey 3		Prey 4		Sediment					TRV				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[damselfly larvae] (mg/kg)[d]	IR_{larvae} (kg/day)[e]	[fish] (mg/kg)[f]	IR_{fish} (kg/day)[g]	[tadpoles] (mg/kg)[h]	$IR_{tadpoles}$ (kg/day)[i]	[plants] (mg/kg)[j]	IR_{plants} (kg/day)[k]	[sediment] (mg/kg)[l]	$IR_{sediment}$ (kg/day)[m]	SUF	Body Weight (kg)[n]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Pond	UCL_{95}	0.09	0.81	0.05	1.45	0.01	5.65	0.01	28.54	0.02	24.04	0.003	1	1.161	0.73	5.49	21.97	X		
Cadmium	Pond	UCL_{95}	0.09	0.09	0.05	0.04	0.01	2.17	0.01	5.57	0.02	10.05	0.003	1	1.161	0.16	0.09	17.64		X	
Copper	Pond	UCL_{95}	0.09	17.12	0.05	8.33	0.01	30.43	0.01	10.31	0.02	81.80	0.003	1	1.161	1.48	2.59	64.39	X		
Lead	Pond	UCL_{95}	0.09	0.24	0.05	0.11	0.01	19.57	0.01	3.34	0.02	129.99	0.003	1	1.161	0.61	0.02	9.43		X	
Mercury*	Pond	UCL_{95}	0.09	0.09	0.05	0.18	0.01	0.11	0.01	0.004	0.02	0.06	0.003	1	1.161	0.01	0.04	0.19	X		
Selenium	Pond	UCL_{95}	0.09	0.77	0.05	4.01	0.01	0.87	0.01	30.15	0.02	1.20	0.003	1	1.161	0.68	0.23	0.94		X	
Zinc	Pond	UCL_{95}	0.09	122.52	0.05	193.86	0.01	668.48	0.01	102.35	0.02	3857.40	0.003	1	1.161	25.43	17.89	178.85		X	

Notes:

a Data from the pond (Unit 13) were used in the dose model.
b The UCL_{95} for soil and tissue data was used in the dose under this dose scenario.
c IR_{prey} calculated using Nagy and others (1999) equation for all birds.
d Damselfly tissue concentrations are from one pond tissue sample.
e IR_{larvae} is 50 percent of IR_{prey}.
f Fish concentrations are maximums from 1995 pond stickleback samples.
g IR_{fish} is 12.5 percent of IR_{prey}.
h Tadpole tissue concentrations are from one pond tissue sample; one-half the detection limit was substituted for nondetects.
i $IR_{tadpole}$ is 12.5 percent of IR_{prey}.
j UCL_{95} concentration in plant tissue.
k IR_{plant} is 25 percent of IR_{prey}.
l UCL_{95} concentration in pond sediment.
m $IR_{sediment}$ is 3.3 percent of IR_{prey}.
n Body weight is an average from EPA (1993).
* Mercury was not analyzed in plant tissues; therefore, the UCL_{95} mercury concentration in pickleweed from RASSs 1 through 4 was used in the dose.

EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilograms per day
mg/kg Milligrams per kilogram
mg/kg-day Milligrams per kilogram per day
RASS Remedial action subsite
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence level of the mean

Source: EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." Annual Review of Nutrition. Volume 19. Pages 247-277.

TABLE G4-8

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE GREAT BLUE HERON (SLOUGH DOSES)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey			Sediment					TRV				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[fish] (mg/kg)[d]	IR_{fish} (kg/day)[e]	Fish Daily Dose (d)	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Slough	UCL_{95}	0.13	1.30	0.13	0.17	76.88	0.004	1	2.39	0.21	6.34	25.38	X		
Cadmium	Slough	UCL_{95}	0.13	0.16	0.13	0.02	19.66	0.004	1	2.39	0.04	0.10	20.38	X		
Copper	Slough	UCL_{95}	0.13	23.95	0.13	3.10	130.94	0.004	1	2.39	1.53	2.99	74.39	X		
Lead	Slough	UCL_{95}	0.13	0.15	0.13	0.02	49.83	0.004	1	2.39	0.10	0.03	10.89		X	
Mercury	Slough	UCL_{95}	0.13	0.12	0.13	0.02	0.46	0.004	1	2.39	0.01	0.05	0.21	X		
Selenium	Slough	UCL_{95}	0.13	0.48	0.13	0.06	1.97	0.004	1	2.39	0.03	0.27	1.08	X		
Zinc	Slough	UCL_{95}	0.13	0.17	0.13	0.32	2,809.50	0.004	1	2.39	5.16	20.66	206.64	X		

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.
b UCL_{95} dose was calculated using UCL_{95} sediment concentration and maximum tissue concentration with exposure parameters for a typical receptor.
c IR_{prey} calculated using Nagy and others (1999) equation for fish eating birds.
d Fish tissue concentrations are the maximum concentrations in fish collected from the slough during 1995.
e IR_{fish} is 100 percent of the IR_{prey}.
f UCL_{95} concentration in slough sediment.
g $IR_{sediment}$ is 3.3 percent of the IR_{prey}.
h Body weight from Dunning (1993).

IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence level of the mean

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.

TABLE G4-8 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE GREAT BLUE HERON (SLOUGH DOSES)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Prey 2		Prey 3		Prey 4		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[fish] (mg/kg)[d]	IR_{fish} (kg/day)[e]	[crayfish] (mg/kg)[f]	$IR_{crayfish}$ (kg/day)[g]	[tad-pole] (mg/kg)[h]	$IR_{tadpole}$ (kg/day)[i]	[rodent] (mg/kg)[j]	IR_{rodent} (kg/day)[k]	[sediment] (mg/kg)[l]	$IR_{sediment}$ (kg/day)[m]	SUF	Body Weight (kg)[n]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Pond	UCL_{95}	0.13	1.45	0.10	2.97	0.01	5.65	0.01	1.33	0.01	24.04	0.004	0.5	2.39	0.07	6.34	25.38	X		
Cadmium	Pond	UCL_{95}	0.13	0.04	0.10	0.32	0.01	2.17	0.01	1.48	0.01	10.05	0.004	0.5	2.39	0.02	0.10	20.38	X		
Copper	Pond	UCL_{95}	0.13	8.33	0.10	120.54	0.01	30.43	0.01	27.52	0.01	81.80	0.004	0.5	2.39	0.66	2.99	74.39	X		
Lead	Pond	UCL_{95}	0.13	0.11	0.10	0.15	0.01	19.57	0.01	3.42	0.01	129.99	0.004	0.5	2.39	0.15	0.03	10.89		X	
Mercury	Pond	UCL_{95}	0.13	0.18	0.11	0.05	0.01	0.11	0.01	NA	NA	0.06	0.004	0.5	2.39	0.004	0.05	0.21	X		
Selenium	Pond	UCL_{95}	0.13	4.01	0.10	0.46	0.01	0.87	0.01	3.79	0.01	1.20	0.004	0.5	2.39	0.10	0.27	1.08	X		
Zinc	Pond	UCL_{95}	0.13	193.86	0.10	114.59	0.01	668.48	0.01	75.23	0.01	3,857.40	0.004	0.5	2.39	8.97	20.66	206.64	X		

Notes:

a Data from the pond (Unit 13) were used in the dose model.
b UCL_{95} dose was calculated using UCL_{95} sediment concentration and maximum tissue concentration with exposure parameters for a typical receptor.
c IR_{prey} calculated using Nagy and others (1999) equation for fish-eating birds.
d Maximum concentration in fish collected from the pond during 1995.
e IR_{fish} is 80 percent of IR_{prey}.
f Maximum concentration in crayfish collected from the pond during 1995.
g $IR_{crayfish}$ is 10 percent of IR_{prey}.
h Maximum concentration in tadpoles collected from the pond during 1995.
i $IR_{tadpole}$ is 5 percent of IR_{prey}.
j UCL_{95} rodent tissue concentration.
k IR_{rodent} is 5 percent of IR_{prey}.
l UCL_{95} concentration in pond sediment.
m $IR_{sediment}$ is 3.3 percent of the IR_{prey}.
n Body weight from Dunning 1993.

IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
NA w
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence level of the mean

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.

TABLE G4-9

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE AMERICAN KESTREL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Soil					TRVs				
Analyte	**Model[a]**	**Dose Type[b]**	**IR_{prey} (kg/day)[c]**	**[Rodent tissue] (mg/kg)[d]**	**IR_{rodent} (kg/day)[e]**	**[soil] (mg/kg)[f]**	**IRsoil (kg/day)[g]**	**SUF**	**Body Weight (kg)[h]**	**Dose (mg/kg day)**	**Low TRV**	**High TRV**	**Below Low TRV**	**Between Low and High TRVs**	**Above High TRV**
Arsenic	RASS 1-3	UCL_{95}	0.02	1.39	0.02	105.52	0.0001	1.00	0.12	0.27	3.48	13.93	X		
	RASS 4	UCL_{95}	0.02	0.92	0.02	51.63	0.0001	0.10	0.12	0.02	3.48	13.93	X		
	Unit 8	UCL_{95}	0.02	1.33	0.02	18.54	0.0001	0.10	0.12	0.02	3.48	13.93	X		
Cadmium	RASS 1-3	UCL_{95}	0.02	1.57	0.02	7.72	0.0001	1.00	0.12	0.21	0.05	11.18		X	
	RASS 4	UCL_{95}	0.02	1.06	0.02	5.73	0.0001	0.10	0.12	0.01	0.05	11.18	X		
	Unit 8	UCL_{95}	0.02	1.48	0.02	0.68	0.0001	0.10	0.12	0.02	0.05	11.18	X		
Copper	RASS 1-3	UCL_{95}	0.02	27.32	0.02	159.02	0.0001	1.00	0.12	3.61	1.64	40.83		X	
	RASS 4	UCL_{95}	0.02	31.75	0.02	54.8	0.0001	0.10	0.12	0.41	1.64	40.83	X		
	Unit 8	UCL_{95}	0.02	27.52	0.02	88.74	0.0001	0.10	0.12	0.36	1.64	40.83	X		
Lead	RASS 1-3	UCL_{95}	0.02	3.59	0.02	97.91	0.0001	1.00	0.12	0.54	0.02	5.98		X	
	RASS 4	UCL_{95}	0.02	2.80	0.02	467.38	0.0001	0.10	0.12	0.08	0.02	5.98		X	
	Unit 8	UCL_{95}	0.02	3.42	0.02	38.17	0.0001	0.10	0.12	0.05	0.02	5.98		X	
Selenium	RASS 1-3	UCL_{95}	0.02	3.43	0.02	1.66	0.0001	1.00	0.12	0.44	0.15	0.60		X	
	RASS 4	UCL_{95}	0.02	7.26	0.02	46.64	0.0001	0.10	0.12	0.10	0.15	0.60	X		
	Unit 8	UCL_{95}	0.02	3.79	0.02	0.77	0.0001	0.10	0.12	0.05	0.15	0.60	X		
Zinc	RASS 1-3	UCL_{95}	0.02	73.87	0.02	1472.15	0.0001	1.00	0.12	10.68	11.34	113.41	X		
	RASS 4	UCL_{95}	0.02	103.62	0.02	202.49	0.0001	0.10	0.12	1.33	11.34	113.41	X		
	Unit 8	UCL_{95}	0.02	75.23	0.02	231.4	0.0001	0.10	0.12	1.34	11.34	113.41	X		

TABLE G4-9 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE AMERICAN KESTREL
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

a Data from RASSs 1 through 3 (Units 1, 2, 4, 6, 12, 13, and 16), RASS 4 (Unit 14), and Unit 8 were used in the dose models.

b UCL_{95} concentration of soil and tissue was used in the dose.

c IR_{prey} calculated using Nagy and others (1999) equation for all birds.

d Rodent tissue concentration is the UCL_{95} of kidney and liver tissue collected from the site in 1991.

e IR_{rodent} is 100 percent of IR_{prey}.

f UCL_{95} concentration of analyte in soil.

g IR_{soil} is 0.7 percent of IR_{prey}.

h Body weight from Roest (1957).

IR	Ingestion rate
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RASS	Remedial action subsite
SUF	Site use factor
TRV	Toxicity reference value
UCL_{95}	One-sided 95 percent upper confidence level of the mean

Source: Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.
Roest, A.I. 1957. "Notes on the American Sparrow Hawk." *Auk*. Volume 74. Number 1. Pages 1-19.

TABLE G4-10

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE NORTHERN HARRIER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey		Soil					TRVs				
Analyte	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[rodent tissue] (mg/kg)[d]	IR_{rodent} (kg/day)[e]	[soil] (mg/kg)[f]	IR_{soil} (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	RASS 1-3	UCL_{95}	0.04	1.39	0.04	105.52	0.0003	1.00	0.44	0.18	4.52	18.10	X		
	RASS 4	UCL_{95}	0.04	0.92	0.04	51.63	0.0003	0.10	0.44	0.01	4.52	18.10	X		
	Unit 8	UCL_{95}	0.04	1.33	0.04	18.54	0.0003	0.10	0.44	0.01	4.52	18.10	X		
Cadmium	RASS 1-3	UCL_{95}	0.04	1.57	0.04	7.72	0.0003	1.00	0.44	0.14	0.07	14.53		X	
	RASS 4	UCL_{95}	0.04	1.06	0.04	5.73	0.0003	0.10	0.44	0.01	0.07	14.53	X		
	Unit 8	UCL_{95}	0.04	1.48	0.04	0.68	0.0003	0.10	0.44	0.01	0.07	14.53	X		
Copper	RASS 1-3	UCL_{95}	0.04	27.32	0.04	159.02	0.0003	1.00	0.44	2.38	2.14	53.05		X	
	RASS 4	UCL_{95}	0.04	31.75	0.04	54.8	0.0003	0.10	0.44	0.27	2.14	53.05	X		
	Unit 8	UCL_{95}	0.04	27.52	0.04	88.74	0.0003	0.10	0.44	0.24	2.14	53.05	X		
Lead	RASS 1-3	UCL_{95}	0.04	3.59	0.04	97.91	0.0003	1.00	0.44	0.36	0.02	7.77		X	
	RASS 4	UCL_{95}	0.04	2.80	0.04	467.38	0.0003	0.10	0.44	0.05	0.02	7.77		X	
	Unit 8	UCL_{95}	0.04	3.42	0.04	38.17	0.0003	0.10	0.44	0.03	0.02	7.77		X	
Selenium	RASS 1-3	UCL_{95}	0.04	3.43	0.04	1.66	0.0003	1.00	0.44	0.29	0.19	0.77		X	
	RASS 4	UCL_{95}	0.04	7.26	0.04	46.64	0.0003	0.10	0.44	0.06	0.19	0.77	X		
	Unit 8	UCL_{95}	0.04	3.79	0.04	0.77	0.0003	0.10	0.44	0.03	0.19	0.77	X		
Zinc	RASS 1-3	UCL_{95}	0.04	73.87	0.04	1,472.15	0.0003	1.00	0.44	7.04	14.74	147.37	X		
	RASS 4	UCL_{95}	0.04	103.62	0.04	202.49	0.0003	0.10	0.44	0.88	14.74	147.37	X		
	Unit 8	UCL_{95}	0.04	75.23	0.04	231.40	0.0003	0.10	0.44	0.64	14.74	147.37	X		

TABLE G4-10 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE NORTHERN HARRIER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

a Data from RASSs 1 through 3 (Units 1, 2, 4, 6, 12, 13, and 16), RASS 4 (Unit 14), and Unit 8 were used in the dose models.

b The UCL_{95} for soil and tissue was used in the dose.

c IR_{prey} calculated using Nagy and others (1999) equation for all birds.

d Rodent tissue concentration is the UCL_{95} of kidney and liver tissue collected from the site in 1991.

e IR_{rodent} is 100 percent of IR_{prey}.

f UCL_{95} concentration of analyte in soil or sediment.

g IR_{soil} is 0.7 percent of IR_{prey}.

h Body weight is from Dunning (1993).

IR	Ingestion rate
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
SUF	Site use factor
TRV	Toxicity reference value
UCL_{95}	One-sided 95 percent upper confidence level of the mean

Source: Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses.* CRC Press. Boca Raton, Florida.

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-11

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE SALT MARSH HARVEST MOUSE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[pickleweed] (mg/kg)[d]	[soil] (mg/kg)[e]	IR_{soil} (kg/day)[f]	SUF	Body Weight (kg)[g]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDT	Marsh Surface	1/2 DL	0.003	0.003	0.033	0.00006	1	0.01	0.001	0.98	19.61	X		
PCBs/Aroclors	Marsh Surface	1/2 DL	0.003	0.08	0.88	0.00006	1	0.01	0.02	0.37	1.34	X		
Total DDT	Marsh Surface	Full DL	0.003	0.01	0.07	0.00006	1	0.01	0.002	0.98	19.61	X		
PCBs/Aroclors	Marsh Surface	Full DL	0.003	0.16	1.76	0.00006	1	0.01	0.05	0.37	1.34	X		

Notes:

a Data from the marsh surface area (Units 1, 2, 4, 6, and 8) were used in this model.

b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.

c IR_{prey} based on Fisler (1963).

d Pickleweed concentrations are based on sediment to plant BAFs for Aroclor-1254 and 4,4'-DDT presented in EPA 1999.

e Maximum concentration of analyte in marsh surface soil or sediment.

f IR_{soil} is 2.4 percent of IR_{prey}.

g Average body weight of males and females measured at site (PRC 1994).

BAF Bioaccumulation factor
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
kg/day Kilograms per day
mg/kg Milligrams per kilogram
mg/kg-day Milligrams per kilogram per day
PCB Polychlorinated biphenyl
PRC PRC Environmental Management, Inc.
TRV Toxicity reference value

Source: EPA. 1999. "Screening-level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Fisler, G.F. 1963. "Adaptation and Speciation in Harvest Mice of the Marshes of San Francisco Bay." *University of California Publ. Zool.* Volume 77. Pages 1-108.
PRC. 1994. "Draft Baseline Conditions Report, Litigation Area Sites, Naval Weapons Station Concord, California." February 14.

TABLE G4-12

ORGANIC CHEMICAL DOSE CALCULATIONS FOR THE RIVER OTTER
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

				Prey 1		Sediment					TRVs				
Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[clam] (mg/kg)[d]	IR_{clam} (kg/day)[e]	[sediment] (mg/kg)[f]	$IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Total DDTs	Slough	1/2 DL	0.22	0.03	0.22	0.04	0.002	0.25	5	0.0004	0.68	13.57	X		
PCBs/Aroclors	Slough	1/2 DL	0.22	0.05	0.22	0.96	0.002	0.25	5	0.001	0.26	0.93	X		
Total DDTs	Slough	Full DL	0.22	0.10	0.22	0.07	0.002	0.25	5	0.001	0.68	13.57	X		
PCBs/Aroclors	Slough	Full DL	0.22	0.22	0.22	1.92	0.002	0.25	5	0.003	0.26	0.93	X		

Notes:

a Data from the slough (Units 9, 10, and 11) were used in the dose model.

b 1/2 DL = One-half the detection limit was substituted for nondetects under this dose scenario.
Full DL = The full detection limit was substituted for nondetects under this dose scenario.

c IR_{prey} calculated using Nagy and others (1999) equation for all mammals.

d Clam concentrations are the maximum from Litigation Area clam samples; total concentrations were calculated using 1/2 DL of Full DL as a substitute for nondetects, as described in note b.

e IR_{clam} is 100 percent of IR_{prey}.

f Maximum concentration in pond sediment.

g $IR_{sediment}$ is 1.0 percent of IR_{clam}.

h Body weight from EPA (1993).

DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
PCB Polychlorinated biphenyl
SUF Site use factor
TRV Toxicity reference value

Source: EPA. 1993. *Wildlife Exposure Factors Handbook Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.
EPA. 1999. "Screening-level Ecological Risk Protocol for Hazardous Waste Combustion Facilities." Office of Solid Waste and Emergency Response. EPA530-D99-001A. August.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition* . Volume 19. Pages 247-277.

TABLE G4-13

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE SALT MARSH HARVEST MOUSE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Analyte	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[pickleweed] (mg/kg)[d]	$IR_{pickleweed}$ (kg/day)[e]	[soil] (mg/kg)[f]	IR_{soil} (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	Unit 1	Max	0.003	0.05	0.003	17.20	0.0001	1	0.01	0.11	0.39	5.40	X		
	Unit 2	Max	0.003	0.05	0.003	75.30	0.0001	1	0.01	0.46	0.39	5.40		X	
	Unit 4	Max	0.003	0.10	0.003	112.12	0.0001	1	0.01	0.68	0.39	5.40		X	
	Unit 6	Max	0.003	0.32	0.003	1,012.80	0.0001	1	0.01	6.03	0.39	5.40			X
	Unit 8	Max	0.003	0.32	0.003	31.48	0.0001	1	0.01	0.26	0.39	5.40	X		
Cadmium	Unit 1	Max	0.003	0.04	0.003	0.41	0.0001	1	0.01	0.01	0.06	2.81	X		
	Unit 2	Max	0.003	0.01	0.003	0.61	0.0001	1	0.01	0.00	0.06	2.81	X		
	Unit 4	Max	0.003	0.02	0.003	1.65	0.0001	1	0.01	0.01	0.06	2.81	X		
	Unit 6	Max	0.003	0.02	0.003	14.60	0.0001	1	0.01	0.09	0.06	2.81		X	
	Unit 8	Max	0.003	0.04	0.003	0.89	0.0001	1	0.01	0.02	0.06	2.81	X		
Copper	Unit 1	Max	0.003	1.40	0.003	67.90	0.0001	1	0.01	0.74	2.84	663.72	X		
	Unit 2	Max	0.003	1.00	0.003	111.96	0.0001	1	0.01	0.90	2.84	663.72	X		
	Unit 4	Max	0.003	1.40	0.003	150.20	0.0001	1	0.01	1.23	2.84	663.72	X		
	Unit 6	Max	0.003	1.90	0.003	881.28	0.0001	1	0.01	5.65	2.84	663.72		X	
	Unit 8	Max	0.003	1.90	0.003	151.05	0.0001	1	0.01	1.35	2.84	663.72	X		
Lead	Unit 1	Max	0.003	1.70	0.003	70.14	0.0001	1	0.01	0.83	0.002	248.70		X	
	Unit 2	Max	0.003	0.09	0.003	96.24	0.0001	1	0.01	0.59	0.002	248.70		X	
	Unit 4	Max	0.003	0.37	0.003	204.20	0.0001	1	0.01	1.29	0.002	248.70		X	
	Unit 6	Max	0.003	0.19	0.003	451.66	0.0001	1	0.01	2.70	0.002	248.70		X	
	Unit 8	Max	0.003	1.70	0.003	41.10	0.0001	1	0.01	0.66	0.002	248.70		X	
Mercury	Unit 1	Max	0.003	0.00	0.003	0.34	0.0001	1	0.01	0.003	0.30	4.99	X		
	Unit 2	Max	0.003	0.01	0.003	0.66	0.0001	1	0.01	0.01	0.30	4.99	X		
	Unit 4	Max	0.003	0.01	0.003	0.53	0.0001	1	0.01	0.00	0.30	4.99	X		
	Unit 6	Max	0.003	0.01	0.003	0.72	0.0001	1	0.01	0.01	0.30	4.99	X		
	Unit 8*	Max	0.003	0.01	0.003	0.72	0.0001	1	0.01	0.01	0.30	4.99	X		
Selenium	Unit 1	Max	0.003	0.09	0.003	2.00	0.0001	1	0.01	0.03	0.06	1.27	X		
	Unit 2	Max	0.003	0.09	0.003	2.24	0.0001	1	0.01	0.03	0.06	1.27	X		
	Unit 4	Max	0.003	0.09	0.003	2.60	0.0001	1	0.01	0.04	0.06	1.27	X		
	Unit 6	Max	0.003	0.09	0.003	4.81	0.0001	1	0.01	0.05	0.06	1.27	X		
	Unit 8	Max	0.003	0.09	0.003	2.02	0.0001	1	0.01	0.03	0.06	1.27	X		
Zinc	Unit 1	Max	0.003	8.00	0.003	152.86	0.0001	1	0.01	2.86	10.11	486.26	X		
	Unit 2	Max	0.003	4.50	0.003	435.80	0.0001	1	0.01	3.67	10.11	486.26	X		
	Unit 4	Max	0.003	5.60	0.003	2,013.60	0.0001	1	0.01	13.21	10.11	486.26		X	
	Unit 6	Max	0.003	13.20	0.003	4,940.00	0.0001	1	0.01	32.28	10.11	486.26		X	
	Unit 8	Max	0.003	13.20	0.003	528.50	0.0001	1	0.01	6.34	10.11	486.26	X		

TABLE G4-13 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONSS FOR THE SALT MARSH HARVEST MOUSE
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

a	Data from Units 1, 2, 4, 6, and 8 (marsh surface area) were used in the model.
b	Maximum doses were calculated using 99th percentile soil or sediment concentration and maximum tissue concentration with exposure parameters for a typical receptor.
c	IR_{prey} based on Fisler (1963).
d	Pickleweed concentrations are maximums (in dry weight) from tissue collected at the site in 1991.
e	$IR_{pickleweed}$ is 100 percent of IR_{prey}.
f	99th percentile concentration of analyte in soil or sediment.
g	IR_{soil} is 2.4 percent of IR_{prey}.
h	Average body weight of males and females measured at site (PRC 1994).
*	Mercury in soil was not evaluated in Unit 8; therefore,the maximum mercury concentration from Units 1, 2, 4, and 6 was used in the dose.
IR	Ingestion rate
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
PRC	PRC Environmental Management, Inc.
SUF	Site use factor
TRV	Toxicity reference value

Source: Fisler, G.F. 1963. "Adaptation and Speciation in Harvest Mice of the Marshes of San Francisco Bay." *University of California Publ. Zool.* Volume 77. Pages 1-108.
PRC. 1994. "Draft Baseline Conditions Report, Litigation Area Sites, Naval Weapons Station Concord, California." February 14.

TABLE G4-14

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE GRAY FOX
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	[rodent] (mg/kg)[d]	IR_{rodent} (kg/day)[e]	[soil] (mg/kg)[f]	IR_{soil} (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	Low TRV	High TRV	Below Low TRV	Between Low and High TRVs	Above High TRV
Arsenic	RASS 1-3	UCL_{95}	0.18	1.39	0.18	105.52	0.005	0.25	4.4	0.04	0.28	3.80	X		
	RASS 4	UCL_{95}	0.18	0.92	0.18	51.63	0.005	0.25	4.4	0.02	0.28	3.80	X		
	Unit 8	UCL_{95}	0.18	1.39	0.18	18.54	0.005	0.25	4.4	0.02	0.28	3.80	X		
Cadmium	RASS 1-3	UCL_{95}	0.18	1.57	0.18	7.72	0.005	0.25	4.4	0.02	0.05	1.98	X		
	RASS 4	UCL_{95}	0.18	1.06	0.18	5.73	0.005	0.25	4.4	0.01	0.05	1.98	X		
	Unit 8	UCL_{95}	0.18	1.57	0.18	0.68	0.005	0.25	4.4	0.02	0.05	1.98	X		
Copper	RASS 1-3	UCL_{95}	0.18	27.32	0.18	159.02	0.005	0.25	4.4	0.32	1.99	466.29	X		
	RASS 4	UCL_{95}	0.18	31.75	0.18	54.80	0.005	0.25	4.4	0.33	1.99	466.29	X		
	Unit 8	UCL_{95}	0.18	31.75	0.18	88.74	0.005	0.25	4.4	0.34	1.99	466.29	X		
Lead	RASS 1-3	UCL_{95}	0.18	3.59	0.18	97.91	0.005	0.25	4.4	0.06	0.00	174.72		X	
	RASS 4	UCL_{95}	0.18	2.80	0.18	467.38	0.005	0.25	4.4	0.16	0.00	174.72		X	
	Unit 8	UCL_{95}	0.18	3.59	0.18	38.17	0.005	0.25	4.4	0.05	0.00	174.72		X	
Selenium	RASS 1-3	UCL_{95}	0.18	3.43	0.18	1.66	0.005	0.25	4.4	0.03	0.04	0.89	X		
	RASS 4	UCL_{95}	0.18	7.26	0.18	46.64	0.005	0.25	4.4	0.09	0.04	0.89		X	
	Unit 8	UCL_{95}	0.18	7.26	0.18	0.77	0.005	0.25	4.4	0.07	0.04	0.89		X	
Zinc	RASS 1-3	UCL_{95}	0.18	73.87	0.18	1472.15	0.005	0.25	4.4	1.16	7.10	341.62	X		
	RASS 4	UCL_{95}	0.18	103.62	0.18	202.49	0.005	0.25	4.4	1.10	7.10	341.62	X		
	Unit 8	UCL_{95}	0.18	103.62	0.18	231.40	0.005	0.25	4.4	1.11	7.10	341.62	X		

TABLE G4-14 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE GRAY FOX
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Notes:

a Data from RASSs 1 through 3 (Units 1, 2, 4, 6, 12, 13, and 16), RASS 4 (Unit 16), and Unit 8 were used in the dose model.

b UCL_{95} concentrations for soil and tissue were used in the dose.

c IR_{prey} calculated using Nagy and others (1999) equation for eutherian mammals.

d Rodent tissue concentrations are based on rodent tissue collected in 1991. No rodents were collected in Unit 8; therefore, the maximum concentration from RASSs 1 through 3 or RASS 4 was used in the dose.

e IR_{rodent} is 100 percent of IR_{prey}.

f UCL_{95} soil concentration.

g IR_{soil} is 2.8 percent of IR_{prey}.

h Body weight from Silvia and Downing (1995).

IR	Ingestion rate
kg/day	Kilogram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RASS	Remedial action subsite
SUF	Site use factor
TRV	Toxicity reference value
UCL_{95}	One-sided 95 percent upper confidence level of the mean

Source: Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.
Silva, M., and J.A. Downing. 1995. *CRC Handbook of Mammalian Body Masses* . CRC Press. Boca Raton, Florida.

TABLE G4-15

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE RIVER OTTER (CLAM DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	Prey 1 [clam] (mg/kg)[d]	Prey 1 IR_{clam} (kg/day)[e]	Sediment [sediment] (mg/kg)[f]	Sediment $IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	TRVs (h) Low TRV	TRVs (h) High TRV	TRVs (h) Below Low TRV	TRVs (h) Between Low and High TRVs	TRVs (h) Above High TRV
Arsenic	Main slough	UCL_{95}	0.215	17.29	0.22	76.88	0.002	0.25	5	0.19	0.27	3.74	X		
Cadmium	Main slough	UCL_{95}	0.215	3.01	0.22	19.66	0.002	0.25	5	0.03	0.04	1.95	X		
Copper	Main slough	UCL_{95}	0.215	103.03	0.22	130.94	0.002	0.25	5	1.12	1.96	459.25	X		
Lead	Main slough	UCL_{95}	0.215	6.00	0.22	49.83	0.002	0.25	5	0.07	0.001	172.08		X	
Mercury	Main slough	UCL_{95}	0.215	1.33	0.22	0.46	0.002	0.25	5	0.01	0.21	3.45	X		
Selenium	Main slough	UCL_{95}	0.215	4.52	0.22	1.97	0.002	0.25	5	0.05	0.04	0.88		X	
Zinc	Main slough	UCL_{95}	0.215	478.08	0.22	2,809.50	0.002	0.25	5	5.44	6.99	336.47	X		

Notes:

a Data from the main slough (Units 9, 10, and 11) were used in the dose model.

b UCL_{95} concentrations for soil and maximum tissue were used in the dose.

c IR_{prey} calculated using Nagy and others (1999) equation for all mammals.

d UCL_{95} clam tissue concentrations from samples collected in 1996 and 2000 were used in the dose.

e IR_{clam} is 100 percent of IR_{prey}.

f UCL_{95} concentration in sediment.

g $IR_{sediment}$ is 1.0 percent of the IR_{prey}.

h Body weight from EPA (1993).

EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95th percentile upper confidence level of the mean

Source: EPA. 1993. *Wildlife Exposure Factors Handbook, Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December.
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.

TABLE G4-15 (Continued)

INORGANIC CHEMICAL DOSE CALCULATIONS FOR THE RIVER OTTER (FISH DIET)
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA

Chemical	Model[a]	Dose Type[b]	IR_{prey} (kg/day)[c]	Prey 1 [fish] (mg/kg)[d]	Prey 1 IR_{fish} (kg/day)[e]	Sediment [sediment] (mg/kg)[f]	Sediment $IR_{sediment}$ (kg/day)[g]	SUF	Body Weight (kg)[h]	Dose (mg/kg-day)	TRVs (h) Low TRV	TRVs (h) High TRV	TRVs (h) Below Low TRV	TRVs (h) Between Low and High TRVs	TRVs (h) Above High TRV
Arsenic	Main slough	UCL_{95}	0.22	1.30	0.22	76.88	0.002	0.25	5	0.02	0.27	3.74	X		
Cadmium	Main slough	UCL_{95}	0.22	1.56	0.22	19.66	0.002	0.25	5	0.02	0.04	1.95	X		
Copper	Main slough	UCL_{95}	0.22	23.95	0.22	130.94	0.002	0.25	5	0.27	1.96	459.25	X		
Lead	Main slough	UCL_{95}	0.22	0.15	0.22	49.83	0.002	0.25	5	0.01	0.001	172.08		X	
Mercury	Main slough	UCL_{95}	0.22	0.12	0.22	0.46	0.002	0.25	5	0.001	0.21	3.45	X		
Selenium	Main slough	UCL_{95}	0.22	0.48	0.22	1.97	0.002	0.25	5	0.01	0.04	0.88	X		
Zinc	Main slough	UCL_{95}	0.22	0.17	0.22	2,809.50	0.002	0.25	5	0.30	6.99	336.47	X		

Notes:

a Data from the main slough (Units 9, 10, and 11) were used in the dose model.
b UCL_{95} concentrations for soil and maximum tissue were used in the dose.
c IR_{prey} calculated using Nagy and others (1999) equation for all mammals.
d Maximum sculpin tissue concentrations from samples collected in 1996 were used in the dose.
e IR_{fish} is 100 percent of IR_{prey}.
f UCL_{95} concentration in sediment.
g $IR_{sediment}$ is 1.0 percent of the IR_{prey}.
g Body weight from EPA (1993).

EPA U.S. Environmental Protection Agency
IR Ingestion rate
kg/day Kilogram per day
mg/kg Milligram per kilogram
mg/kg-day Milligram per kilogram per day
SUF Site use factor
TRV Toxicity reference value
UCL_{95} One-sided 95 percent upper confidence level of the mean

Source: EPA. 1993. *Wildlife Exposure Factors Handbook, Volumes I and II.* EPA/600/R-93/187a and b. Office of Research and Development. December
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. "Energetics of Free-ranging Mammals, Reptiles, and Birds." *Annual Review of Nutrition.* Volume 19. Pages 247-277.

APPENDIX H

RESPONSES TO REGULATORY AGENCY COMMENTS AND RISK MANAGEMENT MEETING MINUTES 5-YEAR PERIODIC REVIEW ASSESSMENT LITIGATION AREA, NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

(95 Pages)

Note: responses to comments and meeting minutes are included in this appendix. All of the documents below will have been delivered as separate deliverables.

- Responses to regulatory agency comments on Draft Five-Year Periodic Review Assessment Report, June 21, 2001)
- Meeting minutes (w/ agenda and handout as attachments): February 22, 2002, risk management meeting
- Meeting minutes (w/ agenda and handout and figures as attachments): March 27, 2002, risk management meeting
- Meeting minutes: March 20, 2003, dispute resolution meeting
- Responses to regulatory agency comments on Draft Final Five-Year Periodic Review Assessment Report, June 30, 2003

RESPONSES TO REGULATORY AGENCY COMMENTS ON THE DRAFT FIVE-YEAR PERIODIC REVIEW ASSESSMENT LITIGATION AREA NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT, CONCORD, CALIFORNIA JUNE 21, 2001

This document presents the Navy's responses to comments from the U.S. Environmental Protection Agency (EPA); California Environmental Protection Agency Department of Toxic Substances Control (DTSC); California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB); and California Department of Fish and Game (CDFG) on the "Draft Five-Year Periodic Review Assessment Litigation Area at the Naval Weapons Station, Seal Beach Detachment, Concord, California," dated June 21, 2001.

The comments addressed below were received in a letter from EPA dated September 27, 2001. Paragraphs from the letter are quoted directly to represent comments from U.S. EPA.

RESPONSES TO COMMENTS FROM EPA

General Comments

1. Comment: **The U.S. Environmental Protection Agency (U.S. EPA) has received and reviewed the draft "Five-Year Review Assessment for Litigation Area Naval Weapons Station, Seal Beach Detachment Concord, California" (Five-Year Review), dated June 21, 200l. The Five-Year Review was prepared by TetraTech EM Inc. on behalf of the Department of the Navy (Navy). For a general summary of the Concord Naval Weapons Station (NWS) Litigation Area, please see Enclosure A. A copy of the Navy's 1989 Record of Decision (ROD) is included as Enclosure B.**

U.S. EPA conducted this review pursuant to Section 121 (c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the National Contingency Plan (NCP) 40 C.F.R. Section 300. 430(f)(4)(ii), and U.S. EPA's Comprehensive Five-Year Review Guidance (Office of Solid Waste and Emergency Response (OSWER) Directive No. 9355.7-03B-P (June 2001)[1]. It is a statutory review. The purpose of a five-year review is to ensure that a remedial action is protective of public health and the environment and is functioning as designed, or if the remedy is not protective, to provide recommendations, including follow-up actions to ensure protectiveness.

As described in the Five-Year Review, the Navy acknowledges that the selected remedies (essentially excavation and backfill, generally using TTLCs/STLCs cleanup levels) are not considered protective at RASS 1 and 3. U.S. EPA agrees that the remedy is not protective in these areas and also has concerns regarding the protectiveness at RASS 4. U.S. EPA also has several concerns with the recommendations for follow-up actions stated in the Five-Year Review. However, rather that spending valuable but limited time and resources on detailed written technical comments or revisions to the Five-Year Review, U.S. EPA recommends that the Navy, the federal and

state regulatory agencies, and the natural Resource Trustees establish a schedule of meetings to discuss the most efficient and effective response to ensure that Navy resources are directed at protecting human health and the environment. At the end of the meeting(s), U.S. EPA envisions the Navy establishing a plan for follow-up actions that would be presented to and approved by the regulatory agencies and the Trustees (and would also include a public participation component).

[1]This document is available at http://www.epa.gov/superfund/pubs.htm

Response: The Navy plans to hold several risk management meetings with the regulatory and trustee agencies to determine what steps should be taken to ensure protectiveness at the Litigation Area site; the first of these meetings was held on February 22, 2002. The Navy submits these formal responses to comments from the agencies and will revise the five-year review report to document plans for the site. More detailed recommendations for the site, based on discussions with the regulatory and trustee agencies, will be documented in the draft final version of the five-year periodic review assessment report.

The Navy submitted a draft community summary report to the agencies and the Restoration Advisory Board (RAB) on February 19, 2002, that presents the conclusions of the five-year review. The Navy plans to make a presentation to the RAB in April or May 2002, regarding the Navy's plans for follow-up actions at the Litigation Area.

2. Comment: **U.S. EPA believes that the major question associated with the necessity for further remedial action at the Litigation Area depends on the "value" of the marsh. The "value" is defined as the ability of the marsh to provide safe habitat for all marsh-dwelling biota including threatened and endangered species known to reside or potentially residing in the Litigation Area. This requires a determination be made in some measured fashion of the current biotic potential (value) of the marsh as determined by comparison with an appropriate reference area. Once this measurement is made, the Navy and the regulators can make an informed decision whether it is necessary to pursue further remediation and, if so, where and to what extent. Therefore, U.S. EPA suggests that a scientifically-based survey be planned and performed to determine the current biotic value of the marsh. When this is complete, we can determine what, if any, actions must be done to bring this issue to closure.**

Response: Because remedial actions in wetlands are generally very destructive, the Navy agrees that the ecological value of the remedial action subsite (RASS) 1 marsh and the impact of remediation must be considered when decisions are made on whether the risk from remaining contaminants warrants additional actions at the site. The Navy maintains that, from the many years of ecological monitoring, sufficient information is available to characterize the value of the Litigation Area wetland without undertaking additional studies.

Based on discussions with the agencies at the February 22, 2002, risk management meeting, the Navy does not plan to conduct a wetlands values

assessment at this time. In the context of the Navy's proposed supplemental feasibility studies for selected portions of RASS 1 (see response to EPA general comment 3), specific questions relating to ecological value of the wetland may need to be addressed through evaluation of existing data or additional study.

The Navy agrees to discuss this issue further with the agencies during the scoping phase for the proposed supplemental feasibility studies for selected parts of RASS 1. Any proposed wetland assessment or other study would be subject to the data quality objective (DQO) process to determine the type of data to be collected, applicability of the data to management decisions, and the criteria for interpreting the data. Specifically, the DQOs must address how the results of the assessment would support decisions on the need for additional actions.

3. Comment: **U.S. EPA has identified a number of problem areas in the Five-Year Review which would require discussion prior to finalization of the document. These are described below. However, U.S. EPA suggests the Navy defer a written response until the marsh survey is completed and a decision is made on the need for action.**

The marsh surface just west of the RASS 1 actively remediated area. It appears that the remedial action did not reach far enough west into Units 6 and 7 to remove significant concentrations of arsenic spilled onto the marsh surface. These concentrations of arsenic pose risk to the endangered salt marsh harvest mouse. Tables 65 and 66 present statistical hot spots based on metal concentrations measured in soil/sediment during the five years of monitoring, and depict areas where ecological risk to special status species is considered significant.

The small arm of Lost Slough (Unit 11), within RASS 1. The slough poses risk to benthic and aquatic invertebrates (clams collected from numerous sample locations have accumulated metals), as well as special status avian receptors such as the black rail.

The mosquito ditches (Unites 6 and 7), within RASS 1. The ditches appear to provide an unregulated mechanism for contaminant transport based upon sediment core analysis and other lines of evidence.

The potential ground water/surface water mixing zone in RASS 1. The Five-Year Review provides evidence that groundwater from neighboring properties (e.g., General Chemical Company) is significantly contaminated. The Navy should install groundwater monitoring wells along the Suisun Bay shoreline in RASS 1 to determine how groundwater may be contributing to sediment and surface water contamination and the extent to which contaminated groundwater is discharging to Suisun Bay.

Nichols Creek and the RASS 3 (Unit 13). The geology and continuity of a described "perched" groundwater zone near Nichols Creek may need additional investigation to determine whether groundwater migrating onto Navy property and into Nichols Creek is an ongoing and significant source of contamination that adversely impacts the environment.

RASS 3 railroad area. The nature and extent of PCB contamination south of the railroad in RASS 3 has not been determined.

<u>RASS 4</u>. Given the site history (waste disposal and coal residue (coke) storage), high residual contamination, and unusual soils observed by U.S. EPA during the July 27, 2001 Site Inspection, additional characterization may be necessary. Also, earlier this month U.S. EPA staff noted that RASS 4 had a brush fire that burned much of the site. U.S. EPA staff orally notified the Navy of this, and was informed that the Navy was already aware of the fire. Section 20.1(b) of the Federal Facility Agreement (FFA) executed by the U.S. EPA and the Navy in June 2001 requires that if any party "discovers or becomes aware of an emergency or other situation that may present an endangerment to public health, welfare or the environment at or near the Facility, which is pertinent to or may affect the work performed under this Agreement, that Party shall notify the other Parties orally within twenty-four hours and will forward written notification within seven (7) days." In the future, please notify U.S. EPA pursuant to the FPA of any accidents such as this which potentially impact environmental sites at the facility.

Response: The following statements represent the Navy's responses to specific EPA concerns outlined in this comment. These issues were also discussed with the agencies at the February 22, 2002, risk management meeting. The Navy will include specific recommendations for each RASS in the draft final five-year periodic review assessment report.

<u>The marsh surface just west of the RASS 1 actively remediated area</u>. The Navy does not believe that the residual contamination in the marsh surface poses a risk that warrants additional action. This conclusion is based on the results of the baseline ecological risk assessment and the evaluation of migration potential. A few locations posed some risk to the salt marsh harvest mouse based on maximum concentrations of arsenic in 6-inch vertical composite cores; however, more detailed vertical profiles of the contaminants showed that higher concentrations are not found at the surface of the soil where mice would be exposed but are buried under several inches of cleaner soil that has accreted on the marsh since the historic spills. A dense layer of vegetation prevents lateral migration of contaminants in the area. The Navy believes that the negative impacts of additional remediation over a wide area of the southeastern marsh surface in RASS 1 would outweigh any potential reduction of risk that could be obtained.

The Navy is willing to consider conducting focused and limited five-year monitoring of this area because contamination was left in place.

<u>The small arm of Lost Slough (Unit 11), within RASS 1</u>. The Navy acknowledges some risk to aquatic invertebrates and fish and black rails and the potential for mobilization of contaminants within Unit 11 in RASS 1. Based on a weight-of-evidence process that included evaluations of risk and concerns about migration potential for the high concentrations of metals present in this area, the Navy will consider additional actions to reduce ecological risk in the small arm of Lost Slough (Unit 11) in RASS 1.

The Navy believes that the best process for evaluating alternative actions is through a supplemental feasibility study. The supplemental feasibility study would evaluate whether additional remedial actions in the Unit 11 slough would reduce risk enough to offset the adverse impacts of the associated habitat destruction. The ecological and economic cost and benefit of remedial alternatives would be evaluated within the context of the ecological value of the wetland and slough in RASS 1.

Since the Unit 11 slough has acted as a "sink" for contaminants migrating from upgradient sources through Nichols Creek, the Navy maintains that upgradient on- and off-site sources must be contained or removed before any additional downgradient remediation is implemented in the slough in RASS 1. Navy policy specifies that sources must be identified and controlled before cleanup ("Policy on Sediment Site Investigation and Response Action, Department of the Navy," Ser N453E/2U589601, February 8, 2002).

The Navy will continue to discuss technical issues and concerns with the agencies about this area during the scoping process for the supplemental feasibility study.

The mosquito ditches (Unites 6 and 7), within RASS 1. The Navy acknowledges some potential for mobilization of high concentrations of metals within the mosquito ditches in Unit 7 in RASS 1. These ditches are not natural features and are less valuable habitat features than the marsh surface or sloughs. Based on concerns that ditches act as potential contaminant transport pathways, the Navy will consider alternatives to reduce contaminant mobility in the ditches in Unit 7.

The Navy believes that the best process for evaluating alternative actions is through a supplemental feasibility study. The ecological and hydrological impacts of remedial alternatives would be evaluated during the supplemental feasibility study phase. The supplemental feasibility study would evaluate whether additional remedial actions would reduce contaminant transport enough to offset the adverse impacts from the associated habitat destruction and alteration of hydrological patterns in the marsh. The ecological and economic cost and benefit of remedial alternatives would be evaluated within the context of the ecological value of the surrounding wetland in RASS 1 that would be impacted by remedial actions focused on the ditches.

The potential groundwater/surface water mixing zone in RASS 1. The Navy does not plan to install groundwater monitoring wells along the shoreline for several reasons.

First, the shoreline is more than 1,000 feet from the closest contaminated soil in RASS 1 and, due to the fine-grained subsurface soils and slow flow rate of groundwater through Bay Muds (on the order of 3 feet per year), it would take decades or centuries for contaminants to reach Suisun Bay through the marsh soils. The abundant organic material and clays in the subsurface offer significant retardation potential, which is expected to further slow the migration of dissolved metals in groundwater and immobilize a significant fraction of dissolved metals.

Second, the shoreline is inaccessible to drill rigs; therefore, wells would have to be installed by hand. It is not feasible to properly install and develop monitoring

wells by hand in this area. The deformable subsurface soils would make it very difficult to install a monitoring well with a screened interval greater than a few feet and maintain a filter pack to separate the well screen from surrounding soils. A shorter screened interval would significantly reduce the performance of the wells, and would inhibit the use of low flow-rate sampling techniques because the wells would be unable to support 0.1 liter per minute recharge rates. Further, the saturated mat of vegetation at the surface would allow water to drain into the borehole making it difficult to isolate deeper zones from contamination that may be present near the surface.

The Navy is also concerned about contaminated groundwater at the General Chemical facility, especially in light of recent observations (July 27, 2001, site visit) of distressed vegetation in the active remediation area of RASS 1 along the berm separating that facility from Navy property. The Navy is willing to consider resampling all of the groundwater wells at the Litigation Area and conducting a focused study to evaluate grab groundwater and soil contamination levels in the area of distressed vegetation and in adjacent areas without distressed vegetation along the berm. If contamination is found in the remediated area of RASS 1, the Navy will work with the regulatory agencies and the neighboring property owners to resolve the problem.

Nichols Creek and RASS 3 (Unit 13). The Navy is concerned about soil erosion along Nichols Creek and the potential for contaminants to migrate to the wetland in RASS 1. Based on these migration concerns, the Navy will consider additional actions to reduce erosion potential in RASS 3. The Navy believes that the best process for evaluating additional actions is through a supplemental feasibility study.

The Navy is concerned about erosional areas along Nichols Creek on railroad property upgradient from RASS 3; the Navy will send letters to the railroad property owners alerting them of the Navy's concerns. As per Navy policy, the Navy maintains that upgradient off-site sources need to be contained or removed before any additional downgradient remediation is performed on Navy property in RASS 3.

RASS 3 railroad area (polychlorinated biphenyls [PCB]). The Navy is willing to consider conducting limited sampling of PCBs on Navy property along the railroad track in RASS 3 to fill spatial data gaps in the PCB sampling effort in this area.

RASS 4. At the February 22, 2002, meeting, the Navy requested further clarification from EPA on what part of the site requires further characterization and why EPA does not consider the remedy at RASS 4 to be protective. EPA representative, Mr. Phillip Ramsey, indicated that the concerns were (1) whether the site uses visible in historic aerial photographs had been evaluated to determine whether areas sampled corresponded to areas of past use that might have contributed contamination, (2) whether the nature of the semilithified soil material observed in the remediated part of RASS 4 during the site visit (July 27, 2001) had been adequately characterized.

The remedial investigation (RI) sampling plan was based on site history. The subsequent monitoring sampling plan was based on a stratified random design agreed to by the regulatory and trustee agencies. The Navy will review the aerial

photographs again to confirm that areas of potential contamination have been sampled and will discuss the results of this review in the draft final five-year periodic review assessment report.

The Navy will also evaluate whether existing samples are collocated with the area of semilithified material seen during the site visit. The Navy will evaluate the existing data and will propose limited sampling of the semilithified soil material, if it has not been adequately characterized.

The Navy will work to ensure closer communication with the agencies on any future events, such as the RASS 4 fire, that affect environmental sites at the installation. The Navy will make periodic observations on the resprouting of coyote bushes and grasses through spring to assess ecological impact of the fire in the revegetated area.

4. Comment: **In general, U.S. EPA believes the Five-Year Review is very thorough and provides a relatively good presentation and analysis of the data collected, for which the Navy should be commended. However, regarding Section 3.5, Regulatory and Trustee Agency Input and Comments on the Remedial Action (pages 3-17), U.S. EPA does not believe the Navy has accurately characterized U.S. EPA response to the Navy's 1989 ROD, which was neither signed nor approved by U.S. EPA. In particular, U.S. EPA does not agree with the statement in Section 3.5, that "[U.S. EPA] … did not object to the ROD and RAP during development of the remedy, despite extensive opportunity for the regulatory agency review …" While these activities occurred more than ten (10) years ago, and documentation may be limited, Navy correspondence dated January 15, 1993 from Gerald Katz, Director of Office of Environmental Management to Keith Takata, at the time U.S. EPA Deputy Director for Superfund, included several statements that contradict the Navy's current characterization of U.S. EPA's response to the Navy's proposed remedy. The Navy states in the initial paragraph of its January 1993 letter, "[U.S. EPA's] letter of 17 November and 31 December 1992 to NWS Concord … recommended that the Navy postpone remedial actions that are already underway, pending [U.S. EPA's] further study of the pertinent site documentation." The letter further states, "[w]hile we are aware that [U.S. EPA] must review the results of a RI/FS conducted for a Federal facility listed on the NPL, the Navy cannot agree with your recommendation to "postpone" remedial activities now underway in the Litigation Area, because the final remedial action plan selected in 1989, the consent decrees entered in U.S. District Court, and the remedial design now being implemented by the private parties and the Navy govern the response at the Litigation Area." U.S. EPA's purpose in pointing this out is to ensure that the Navy recognize that U.S. EPA did not sign the ROD nor concur with the selected remedy. On the contrary, U.S. EPA expressed concerns about the proposed remedy, and after the Navy selected the remedy, U.S. EPA discussed with the Navy areas of the site that may require additional remedial actions that may need to be documented in a focused feasibility study and a ROD Amendment.**

Response: The Navy appreciates the positive comments on the thoroughness and presentation of the draft five-year periodic review assessment report. The Navy worked closely with EPA and the other agencies to design the review and to address outstanding concerns on the part of the regulatory and trustee agencies.

The Navy stands by its statement that EPA did not comment on the record of decision (ROD) or remedy design documents during the review period. While the Navy acknowledges that EPA may have had concerns about the proposed remedy, no documents have been located that show those concerns were received in time to influence the remedy design process or decision documents. The letters cited in the comment above were dated in 1992 and 1993, well after the signing of the ROD and selection of the remedy in 1989. Therefore, the Navy, as lead agency, determined that the remedy should proceed as planned. The revised draft final five-year periodic review assessment report will clarify that EPA did not sign the ROD and expressed concerns about the proposed remedy 3 years after the ROD was signed and the design documents were completed.

The Navy has made great effort and incurred additional expense to address EPA's concerns by conducting a qualitative ecological assessment in 1995 to 1996, redesigning the monitoring program, and conducting many additional focused studies during the monitoring program at EPA's request.

The comments addressed below were received from DTSC in a memorandum dated December 3, 2001.

RESPONSES TO COMMENTS FROM DTSC

General Comments

1. Comment: **<u>Overall</u>: This is an excellent presentation of human and ecological risk. The Navy stated that they wished to produce an ecological risk assessment that is adequate under current guidelines and they have done so. The protectiveness of the remedy is probably adequate with respect to human health, provided institutional controls prevent any residential development of the area. The Navy is to be commended for their efforts toward protecting non-human species, including rare, threatened, endangered, and special status species. However, DTSC and the other regulatory agencies and trustees recommend continued monitoring to assure that the current degree of protectiveness for these species will endure if conditions were to change in the future. The document can become acceptable upon adequate response to the comments below.**

Response: The Navy appreciates the positive comments on the thoroughness and presentation of the risk assessment components of the draft five-year periodic review assessment report. The Navy worked closely with DTSC and the other agencies to design the risk assessments to meet the requirements of current guidance.

At this time, the Navy does not plan to conduct annual monitoring. Because outstanding issues of concern still exist, the Navy is willing to consider conducting focused, specific studies to address specific objectives or data gaps while decisions are being made about the need for additional action at the site. Data needs will be considered in the context of the proposed supplemental feasibility studies focused on specific parts of the site.

The Navy is also willing to consider conducting limited monitoring at 5-year intervals and would develop a new monitoring plan before the next 5-year monitoring event. Any future monitoring plan would have very specific objectives and would follow the DQO process, as discussed in Section 10.1 of the draft five-year periodic review assessment report.

The Navy plans to revise the five-year review report to include the results of the site inspection tour and more specific recommendations for next steps at the site; a draft final five-year periodic review assessment report will be submitted in Spring 2002 following discussions at risk management meetings.

2. Comment: **Human Health Risk Assessment: Although potential residents might be at risk at some locations, we agree with the Navy that this parcel will remain open land for the foreseeable future. Risks for the mosquito abatement worker fall either below 1 E-6 or at the lower end of the "risk management range" of 1 E-6 to 1 E-4.**

Response: Comment acknowledged. Please see the response to DTSC specific comment 5 regarding risk levels for the mosquito abatement worker.

3. Comment: **Ecological Risk Assessment: We agree with the Navy that the chosen remedies have been at least partially successful. However, we also believe that the presence of significant residual contamination with metals, insecticides, and polychlorinated biphenyls (PCB) call for continued monitoring. Such monitoring should include evaluation of the health of the marsh ecosystem as a whole.**

Response: Please see response to DTSC general comment 1.

Specific Comments

1. Comment: **Habitat Restoration, Secs. 6.3.4.2 ff., pp. 6-14 ff.: During our site tour of 27 July 2001, we visited the revegetated areas. We agree with the Navy's assessment on page 6-15 that these areas have generally not met the original criteria, as shown in page 6-14, but that progress is satisfactory toward the goals of the remediation effort. This success is reflected in the increased numbers of salt marsh harvest mice and California clapper rails counted in the annual surveys. Numbers of rails approximately doubled during the five years of monitoring (page 6-16).**

Response: The marsh revegetation efforts in the active remediation area of RASS 1 were considered successful because the percent cover of native vegetation exceeded the 80 percent native plant cover success criteria for all plant associations except in the refugial mound areas. The revegetation efforts in some portions of RASS 2 did not meet the 80 percent native plant cover success criterion because the elevation of this area is too high to support wetland plant associations. However, the areas are fully vegetated, and the Navy agrees that progress toward the success criteria is satisfactory to meet the goals of the restoration effort.

2. Comment: **Continuing Source Areas, Sec. 6.4.1, pp. 6-20 ff.: The Navy states that nearby properties act as continuing sources for metals such as arsenic and zinc. We agree with the Navy that the Allied Signal/General Chemical facility to the east, which remains unremediated, is almost certainly a source of arsenic and other metals to the eastern portion of the Litigation Area. The partially remediated Chemical and Pigment Company site to the south might be acting as a source of zinc to Nichols Creek and the Litigation Area. We agree with the Navy that the railroad right-of-way continues to act as a source for contamination with zinc and other substances. Indeed, we observed during our site visit of 27 July 2001 that a rail car was leaking a white powder onto the tracks and windblown material was wafting into the marshes in the Litigation Area.**

Response: In accordance with Navy policy, the Navy maintains that upgradient off-site sources need to be controlled or removed before any additional downgradient remediation occurs on Navy property. The Navy is willing to continue discussion of downgradient areas of concern on Navy property with the agencies in the interim period while neighboring sources are addressed.

The Navy is planning to write letters to neighboring property owners and regulatory agencies documenting the Navy's concerns. The Navy is willing to consider conducting some limited studies to further assess the impact of neighboring sources on Navy property as described in the following paragraphs.

Chemical Pigment Company (CPC): The Navy and agencies have significant concerns about CPC as an ongoing source because of the presence of an uncovered stockpile of contaminated soil and high levels of metals in groundwater at the CPC site that borders Nichols Creek.

The Navy will send a letter of concern regarding the contaminated stockpile and contaminated groundwater to the DTSC remedial project managers (RPM) responsible for this site. The Navy requests DTSC's cooperation in resolving these issues and will work with the DTSC RPMs to ensure that the Navy's concerns are understood.

The Navy is willing to consider conducting a small focused study to evaluate groundwater-surface water interactions at the CPC and Navy property boundary. Lithologic relationships between CPC and the Litigation Area are not well understood, especially with respect to a perched groundwater zone reported at CPC. The objectives of the study would be to (1) establish whether a groundwater-surface water preferential flow pathway exists by evaluating lithology at the northwestern corner of the CPC property; (2) create geologic

cross sections that extend across the site boundary onto CPC using existing well logs from the "Hydrogeologic Assessment Report for an Impoundment at 600 Nichols Road, Pittsburg, California" prepared by Environmental Solutions, Inc. in December 1987, and if necessary, install an additional monitoring well on Navy property near CPC to provide detailed lithologic information in the critical area between CPC and Nichols Creek and to assess contaminant concentrations migrating onto Navy property; and (3) assess the recharge/discharge relationship between CPC and Nichols Creek by obtaining concurrent surface water and groundwater elevations and elevations of the base of Nichols Creek.

The Navy maintains that upgradient, non-Navy sources at CPC need to be addressed and removed before any additional downgradient remediation is conducted on Navy property in RASS 3 or RASS 1.

Railroad Erosion Areas: The Navy and agencies have concerns about extensive erosion observed along railroad right-of-ways in RASS 3.

The Navy will send letters of concern to the appropriate railroad property owners requesting their cooperation in resolving issues regarding erosion of metals-contaminated soil onto Navy property.

The Navy maintains that upgradient, non-Navy sources in the railroad right of ways need to be contained or removed before any additional downgradient remediation in RASS 3 or RASS 1.

General Chemical Facility: The Navy and agencies have significant concerns that the General Chemical facility (including General Chemical Company and the Honeywell, Inc. aluminum waste ponds) may be an ongoing source of contaminants to the Litigation area. The file review conducted by the Navy documented high groundwater and soil concentrations of metals and a westward flow of groundwater toward the Litigation Area based on sampling conducted at the General Chemical facility. During the July 2002 site inspection tour of the Litigation Area, an area of distressed vegetation was observed in the remediated area of RASS 1 along the berm separating the General Chemical facility and Honeywell, Inc aluminum waste ponds from the Navy's property.

The Navy is willing to consider conducting a small focused study to evaluate groundwater and soil contamination levels along the berm in the area of distressed vegetation to document whether chemicals are migrating onto Navy property from offsite. Lithologic relationships between General Chemical and the Litigation Area are not well understood. The objective of the study would be as follows: (1) create geologic cross sections that extend across the site boundary onto General Chemical using existing well logs from "Technical Memorandum, Fate and Transport Evaluation: Metals in Groundwater, General Chemical Corporation Bay Point Works Facility" and "Work Plan for On-site Vertical Gradient and Chemistry Evaluation, General Chemical Corporation Bay Point Works Facility" prepared by Montgomery Watson and (2) document the presence or absence of new contamination in the area of distressed vegetation in the remediated portion of RASS 1 along the berm separating the two properties.

The Navy would contact the property owners and regulatory agencies if any contaminant migration or recontamination of cleaned up areas is indicated.

The Navy maintains that upgradient, non-Navy sources at the General Chemical facility need to be controlled or removed before any additional downgradient remediation is conducted on Navy property in RASS 1.

Atchison Topeka Santa Fe (ATSF) Railroad (railcar spills): Between July and September 2002, the regulatory agencies and Navy contractors repeatedly observed railcar spills of white aluminum-based powder along the railroad spur owned by ATSF leading into the General Chemical facility on the edge of RASS 1. Since the spills occurred on railroad property, the Navy will send a letter outlining its concerns to ATSF and requesting resolution to this problem. The baseline ecological risk assessment (Appendix G) will be revised to reflect new information on the probable source of high concentrations of aluminum in the surface water in RASS 1.

3. Comment: **Sediment Migration, Secs. 6.4.3 ff., pp. 6-23 ff.: The Navy has clearly demonstrated that cleaner sediments are gradually covering older, relatively immobile metal-contaminated sediments in the marsh. We have no way of knowing whether this net accretion of sediment will continue or if erosion will uncover the contaminated materials, leading to possible exposure of organisms in the Litigation Area. For now, the situation seems stable, but further monitoring would seem to be appropriate.**

Response: As stated in the recommendations on monitoring in Section 10.1 of the draft five-year periodic review assessment report, the design of future sediment contamination sampling should take into account the vertical profile of contamination observed in the x-ray fluorescence cores. Monitoring the continued burial of contaminated sediments by cleaner sediments would require the incremental analysis of layers of sediment, rather than compositing the top 6 inches as occurred during the 5 years of monitoring.

Monitoring the marsh surface elevation precisely enough to assess incremental uplift or erosion of the marsh surface from year to year is not technically feasible, due to the degree of accuracy required, and the heavy vegetative cover of the marsh surface. However, the draft five-year periodic review assessment report noted that widespread uplift of the marsh surface because of regional tectonism could cause eventual erosion of contaminated soil horizons. The Navy is willing to consider periodically surveying the elevations of the tops of groundwater wells at the site compared to a known benchmark to assess whether elevation changes sufficient to cause erosion of the marsh surface have occurred.

4. Comment: **Tier 1 Assessment for Human Residents, Sec. 6.5, p. 6-26 & Appendix F: The Tier 1 screen compared sample-by-sample concentrations of contaminants to USEPA Region 9 residential Preliminary Remediation Goals (PRG). Many samples exceeded the nominal benchmarks of 1 E-6 for cancer risk and 1.0 for non-cancer hazard. Because this is a wetland habitat and is highly likely to remain so, this information is useful for the sake of completeness, but should not form the basis for risk management decisions at the Litigation Area.**

Response: The Navy concurs that comparisons with EPA Region 9 residential PRGs should not form the basis for risk management decisions at the Litigation Area. The information provided in the Tier 2 screen, which evaluated a site-specific receptor (the mosquito abatement worker), provides the most relevant information for risk management decisions.

5. Comment: **Tier 2 Assessment for Mosquito Abatement Worker, Sec. 6.5, p. 6-27 & Appendix F: The Navy estimated cancer risks and non-cancer hazards for the mosquito abatement worker, which is the correct receptor for this wetland environment. Estimates were made on a sample-by-sample basis. Therefore, we agree with the Navy that the best presentation for the risk manager comes from examining percentiles of the distributions of risk and hazard from the estimates for the Tier 2 estimates of risk (Sec.F4.4. pp. F-33 ff.). At Remedial Action Sub-Site (RASS) 1, the 50th and 95th percentiles of cancer risks were 1 E-5 and 1 E-4, respectively. The principal risk driver is arsenic in soil. The highest risk locations are at the east portion of RASS 1, near the remediated area. Cancer risks at RASS 1 fall into the "risk management range" of 1 E-6 to 1 E-4 and require a site-specific evaluation by risk managers. At RASS 2, 3 and 4, the 95th percentile of cancer risks were less than 1 E-6 and therefore not significant. Non-cancer hazard indices for the mosquito abatement worker were less than the benchmark of 1.0 at RASS 1, 2, 3, and 4. We agree with the Navy that the remedy is adequately protective for the mosquito abatement worker at RASS 2, 3, and 4.**

Response: The 50th and 95th percentile cancer risk estimates for the mosquito abatement worker at RASS 1 are within (50th percentile) or at the upper end (95th percentile) of the risk management range. Although the highest risks were observed at RASS 1, the comment incorrectly notes that the 95th percentiles of cancer risk are less than 1×10^{-6} in RASSs 2, 3, and 4. Although cancer risks in RASSs 2, 3, and 4 were less than the risks in RASS 1, the 50th and 95th percentile risks for these RASSs were within (and not less than) the risk management range (see Table 39 in the draft five-year periodic review assessment report).

As discussed in Appendix F, Section 4.4, the approach for selecting chemicals of potential concern (COPC) for the Tier 2 screen contained biases that overestimated site risks. Sampling locations where detected concentrations of all analytes were less than ambient limits and preliminary remediation goals (PRG) were not evaluated in the Tier 2 screen. Eliminating these locations shifted the distribution of risks because all locations at the lower end of the risk distribution were eliminated from the analysis. Thus the conservative nature of the analyses conducted should be considered during risk management discussions; a more representative distribution would be obtained by including all locations (and COPCs) in the analysis.

The Navy acknowledges DTSC's position that risk management decisions are required for areas where cancer risks fall within or exceed the risk management range. The Navy believes that existing conditions at RASSs 1, 2, 3, and 4 are protective for the mosquito abatement worker and that the existing remedy is

adequately protective as long as controls are in place to prevent residential development of the area. The Navy plans to hold meetings with the regulatory and trustee agencies at which risk management decisions required for protection of human health are discussed.

6. **Comment:** **Page F-31: Please correct the typographical error in "upper bound" in Section 4.2.1.**

Response: The typographical error will be corrected.

7. **Comment:** **Bioavailability and Bioaccumulation of Metals, Sec. G5.3.3, pp. G-90 ff.: The Navy has gathered adequate data on tissue residues to support its conclusion that a large fraction of the zinc and copper in sediment and soil is not bioavailable. The absence of elevated tissue residues of the six metals that are contaminants of potential ecological concern (COPEC) is consistent with data on chemical assays showing high organic carbon and acid-volatile sulfide in soils and sediments, respectively. Tables 70 through 76 demonstrate that no significant amount or pattern of bioaccumulation of these metals (As, Cd, Cu, Pb, Hg, Se, Zn) is occurring in plants or animals at the site. The text in this section is quite informative and useful on the subject of the bioavailability of the COPEC metals.**

Response: The Navy acknowledges this comment and appreciates DTSC's positive assessment of this work.

8. **Comment:** **River Otter, Sec. 6.3.4.3, p. G-144: The unnumbered table on this page shows zeros for Toxicity Reference Value Low (TRV-Low) for lead and for some hazard quotients (HQ). Please show the values actually used, using scientific notation, if necessary.**

Response: This table will be corrected, and the revised version will be included in the draft final five-year periodic review assessment report.

9. **Comment:** **Risk Characterization for Plants, Sec. G.7.2, pp. G-146 ff., Table 107: We concur with the weight-of-evidence summarized in Table 107. Plants may be at risk in areas with the highest concentrations of metals. These are principally in Spatial Units 6, 8, and 12 of RASS 1. During our site visit, we noted areas of bare ground in the east section of Unit 8 of RASS 1, probably an indication of the continuing presence of contamination with arsenic. The Navy selected four special status plants: Mason's lilaeopsis, tule pea, pickleweed, and Soft bird's beak. Numbers of the first two species are stable, probably because they are in areas unaffected by contamination. Numbers of the latter two have been seen to be increasing over the five years of monitoring. The apparent increase in numbers of the threatened salt marsh harvest mouse, which depends on pickleweed, indicates that this critical plant species has undergone significant recovery following remediation. The Navy notes, however, that revegetation with pickleweed**

has not been as successful as had been hoped. The Navy should continue its efforts at revegetation. We agree with the Navy that invasive non-native species pose a greater threat to plants at the Litigation Area, on a population basis, than does chemical contamination.

Response: Please see the response to DTSC specific comment 1. At this time, the Navy does not plan to conduct additional revegetation measures.

10. Comment: **Risk Characterization for Fish and Aquatic Invertebrates, Sec. G.7.3, pp. G-150 ff., Tables 108-109: We agree with the Navy that DDT and PCBs do not currently pose a threat to fish and invertebrates, despite their presence in soils and sediment, because bioaccumulation is not occurring (Table 108). The Navy correctly points out that sediment bioassays showed some evidence of toxicity to invertebrates but not fish. The presence of significant but currently immobile quantities of As, Hg, Se, and Zn in sediments indicates the need for continued monitoring in the ditches, sloughs, and marsh (Table 109). These metals are currently not highly bioavailable, but future events could change this situation. We agree with the Navy that the co-occurrence of toxicity in bioassays and the potential for bioaccumulation at some point in the future indicates that monitoring effects on fish and aquatic invertebrates should focus on Lost Slough.**

Response: Please see the responses to DTSC general comment 1 and EPA general comment 3.

11. Comment: **Risk Characterization for Birds and Mammals, Sec. G.7.4, pp. G-155 ff., Tables 111-112: For DDT and PCBs (Table 111), HQs for the mallard and black rail were greater than 1.0 when averaged across the site, using doses modeled through the food chain and comparing to the TRV-Low. When the same doses were compared to the TRV-High, some HQs fell in the range of 1.0-3.99 for the black rail and mallard, depending on diet and location. We concur that relatively small exceedances of TRV-High in a small number of locations probably do not have an important deleterious effect on the mallard when considered on a population basis. However, the California black rail is considered threatened; therefore, we are concerned about exceedances of both TRV-High and TRV-Low for this bird. HQs for the great blue heron, raptors, and mammals were all less than 1.0.**

We concur with the Navy's conclusions that the mallard, great blue heron, harrier, kestrel, fox, salt marsh harvest mouse, and river otter are adequately protected at the Litigation Area. Indeed, the habitat for all these species has been improved by the remediation carried out to date. We do not agree with the conclusion that the California black rail is currently adequately protected. If continued monitoring provides evidence that successful nesting for this species is increasing as monitoring continues, then we might withdraw this objection at some time in the future.

Response: The Navy has acknowledged that there may be some unacceptable risk to aquatic invertebrates and fish and black rails in Unit 11 and the ditches in Unit 7 (see the Navy response to EPA general comment 3). The Navy believes that the best approach for evaluating alternatives to reduce ecological risk is through a supplemental feasibility study as discussed in EPA general comment 3. The Navy's position on continued monitoring at the site has been addressed in the response to DTSC's general comment 1.

12. Comment: **Navy's Recommendations, Sec. 10.1, pp. 10-1 ff.: We agree with most of the Navy's recommendations, including their recommendation that the intensity of monitoring can be safely decreased. However, all the participating regulatory agencies and/or trustees agree that annual monitoring of some sort must be continued to examine the following areas of concern:**

- **Mobilization of metals to more bioavailable forms.**
- **Success of revegetation with native species.**
- **Nesting success of the California black rail.**
- **Monitoring the Litigation Area annually for these three measurement endpoints is consistent with the Navy's desire to be focus on risk-based questions. We agree with the Navy that monitoring less often, perhaps every five years, is adequate to examine the following areas:**
- **Changes in land use.**
- **Toxicity to fish and aquatic invertebrates.**
- **Soil erosion in waterways.**
- **Health of the ecosystem as a whole.**

Response: Please see the response regarding future monitoring in DTSC general comment 1.

Conclusions and Recommendations

1. Comment: **The remediation efforts undertaken by the Navy at the Litigation Area have reduced risk and hazard to human and non-human species. Habitat has been significantly restored, especially in the wetland areas. Given current land use, we believe humans are adequately protected. Non-human species are protected somewhat less well, but we do not recommend further remediation at this time. All the participating trustee agencies have agreed that annual monitoring at the site should include measurements of the mobilization of toxic metals, the success of revegetation, and the nesting success of the threatened California black rail. Longer-term monitoring of the site should focus of the health of the biological communities as a whole.**

Response: The Navy appreciates DTSC's positive comments on the Navy's efforts to date to reduce risk at the site. In regards to further monitoring, please see the response to DTSC general comment 1.

The comments addressed below were received from RWQCB in a letter dated September 17, 2001.

RESPONSES TO COMMENTS FROM RWQCB

General Comments

1. Comment: **Board staff agrees with the Navy that the existence of contaminated sediments from the ditches in Unit 7, marsh plain surface soils in the vicinity of those ditches, as well as sediment in the slough in Units 10 and 11 present potential ecological risks and should be a high priority. The Navy's position that offsite upgradient sources need to be removed prior to addressing these RASS areas is not supported by the report. Based on the data presented in the report, the area of excavation in RASS 1 has remained at fairly stable contaminant levels post-remediation in surface soils. The majority of the contamination in the areas of passive remediation appears to represent historically-deposited contaminants.**

Response: While most contamination in the passive areas of RASS 1 was probably historically deposited, the Navy and the agencies have identified the migration of contaminants from RASS 3 to the wetland in RASS 1 via Nichols Creek as an issue of concern. In particular, the contaminated surficial sediments in units 7, 10, and 11 may be related to water-borne contaminants from Nichols Creek. Unit 11, in particular, has acted as a "sink" of contaminants (especially zinc) migrating down Nichols Creek. The Navy maintains that any additional actions at the site should focus on upgradient sources before addressing downgradient areas of contamination.

For Navy responses and recommendations on areas of concern identified in this comment, please see the response to EPA general comment 3.

2. Comment: **The five-year review includes an analysis of those areas the Navy considers to be statistically defined contaminant hotspots. This information is provided in Table 65. The report needs to provide a spatial display of the results of the analysis. It would be helpful to compare these contaminated hotspot areas to those areas identified as posing ecological risks.**

Response: The Navy prepared transparent overlays of the hotspot data from Table 65 that can be used to make comparisons with the risk footprints prepared for fish and aquatic invertebrates (Figure 93) and the black rail and salt marsh harvest mouse (Figure 94). The Navy presented this information to the regulatory and trustee agencies at a risk management meeting on February 22, 2002. The Navy will consider the value of incorporating these hotspot maps into the draft final five-year periodic review assessment report.

3. **Comment:** **Board staff is concerned that inadequate sampling was conducted at RASS 4. The operational history of some portions of the parcel was not considered during the sampling effort conducted to date. Organic contaminants appear to pose unacceptable risks at this RASS area.**

Response: The operational history of the site was considered in the original RI sampling and the selection of areas for remediation. The monitoring sampling locations were selected using a stratified random approach that was consistent with the sampling design for the other RASSs and was approved by the regulatory and trustee agencies. Please see response to EPA general comment 3.

The baseline ecological risk assessment concluded that organic contaminants, particularly pesticides detected above effects range-median concentrations in one location in the wetland, do not pose an unacceptable risk.

4. **Comment:** **The Navy has recommended that additional investigations be conducted to address off-site sources and contaminant migration. One of the recommendations is to evaluate the relationship between the perched zone at CPC and Nichols Creek and to install a new monitoring well to evaluate the direction and rate of flow of groundwater in the area. Please clarify whether the Navy is suggesting that it will proceed with these recommendations.**

Response: Please see the response to EPA general comment 3.

5. **Comment:** **The Navy also recommends that additional removal actions or site mitigation activities such as bank stabilization should be evaluated along Nichols Creek in RASS 3. Board staff supports this recommendation and suggests that further evaluation of this recommendation needs to be conducted.**

Response: Please see the response to EPA general comment 3.

6. **Comment:** **Contaminant migration within the sloughs and ditches is poorly characterized and quantified. The report needs to improve the current understanding of contaminant migration in the litigation area for both ground and surface waters.**

Response: The Navy has conducted extensive monitoring and undertaken special studies to address contaminant migration in groundwater and surface water at the site. From those efforts, the Navy has a good understanding of general patterns of contaminant migration, including the concentration of contaminants on incoming and outgoing tides, seasonal variation in surface water quality, concentration of contaminants in groundwater, and direction and rate of flow of groundwater. The Navy does not believe that additional study will better quantify mass flux of contaminants in this dynamic system and has recommended supplemental feasibility studies to address contaminant migration concerns.

Technical issues related to groundwater and surface water migration that are relevant to implementation of remedial alternatives would be evaluated in the supplemental feasibility study and would be discussed with the agencies during the scoping phase.

7. Comment: **Board staff agrees with the Navy's recommendation in Section 10-3 that they consider posting the area with signs warning of existing environmental hazards. The effectiveness of the existing control measures needs to be evaluated.**

Response: The Navy will consider posting signs warning of the presence of hazardous waste in all RASSs and will consider constructing a more secure perimeter around RASS 4**.** A more complete evaluation of the effectiveness of the existing control measures will be provided in the Draft final five-year periodic review assessment report.

8. Comment: **Board staff recommends that the Navy identify a marsh/slough reference site that is not part of the litigation area for use in evaluating the biological impacts of both the active and passive remediation implemented at the site. The current selected tidal wetland/ slough reference site is geographically contiguous with the litigation area.**

Response: The Navy has been unable to identify a marsh/slough reference area that is uncontaminated and has similar hydrology and vegetation diversity as the Litigation Area. After numerous discussions with the regulatory agencies during the monitoring program, it was agreed that the northwestern corner of RASS 1 would serve as a suitable marsh reference area because of low levels of contamination (most metals are below effects range-low in this area) and similar vegetation composition to the contaminated portion of RASS 1. During the October 2000 sampling event, the mouth of Lost Slough was proposed as a slough reference area. The results of that sampling event showed low sediment and surface water concentrations of metals (generally below available toxicity benchmarks), but some elevated metals concentrations in clam tissue. The Navy is not aware of a tidal slough in the southern part of Suisun Bay that has not been contaminated by regional industrial activities.

In addition, there are significant technical concerns about single-reference (control) site versus impacted site comparisons; multiple control sites are needed to accurately assess differences. In the absence of multiple suitable reference sites for an impact-multiple control comparison, the Navy used a gradient approach within the site to assess impacts.

9. Comment: **Board staff recommends reinitiating groundwater sampling at the litigation area. Groundwater sampling has not been performed since October 1996. Board staff suggests that groundwater sampling focus on the following locations in order to improve our current understanding of contaminant fate and transport in the saturated zone: 1) West of the General Chemical Bay Point Works (RASS 1; Units 7 & 8); 2) RASS 2 adjacent and north of the**

railroad tracks. Contouring of the available data would be helpful for interpreting contaminant transport.

Response: The Navy acknowledges that groundwater has not been sampled since 1996; however, 18 rounds of groundwater sampling were conducted as of 1996 when the agencies agreed that groundwater monitoring could be eliminated from the monitoring program. The Navy is willing to consider conducting one round of groundwater sampling for metals in all existing groundwater wells to provide more current information on groundwater quality. The Navy will evaluate the existing data and will conduct additional rounds of sampling if the data show evidence of seasonality. In addition, some new wells may be needed in areas next to neighboring sources to address ongoing concerns about groundwater migration from off-site sources. Selected isoconcentration contour maps will be prepared to better illustrate the distribution of contaminants in groundwater.

The Navy will meet with the agencies to discuss groundwater technical issues and data gaps during the development of a groundwater sampling plan.

10. Comment: **Board staff suggests including a discussion section in the body of the report that discusses the workplan development and why certain components of the workplan were not conducted during the five-year review.**

Response: Section 5.3 of the report will be expanded to include a discussion of the work plan development for the five-year review. Section 5.4 of the draft final report will explain why the *Neomysis* surface water bioassay, identified as a component in the work plan, could not be conducted during the October 2000 field effort.

Specific Comments

1. Comment: **Section 4.2.3: Further characterization of the steel pipeline uncovered during work at RASS 3 needs to be provided. Hydrocarbon contamination at RASS 3 is referenced. Has this contamination been addressed?**

Response: Hydrocarbon contaminated soil discovered in RASS 3 was delineated in 1993; contaminated soil within the active remediation area was removed during the remedial action. The remaining hydrocarbon contamination, found 3.5 to 12 feet below ground surface, was not remediated for the following reasons:
(1) exposure pathways were incomplete, (2) no volatile organic compounds were detected in samples from groundwater wells nearby, and (3) low permeability of the clay soil is expected to limit the migration of contaminants (PRC Environmental Management, Inc. 1993). The Navy does not believe that the low levels of total petroleum hydrocarbons found at depth at this site warrant further characterization or remediation.

2. Comment: **Pages E-18 and G-31: A sampling plan for PCB along the railroad tracks adjacent to RASS 2 and 3 needs to be provided.**

Response: The Navy's ecological risk assessment found no significant unacceptable risk to birds and mammals from PCBs at concentrations found on Navy property near the railroad tracks (Appendix G, Section 7.4). However, to address the spatial data gap in PCB sampling, the Navy is willing to consider conducting limited sampling of PCBs on Navy property along the railroad track in RASS 3.

3. Comment: **Section 6.3.4.2: What is the Navy's plan to address the lack of success in its revegetation efforts as presented in this section of the report? A table indicating the inventory of plant species distribution and percentage cover for all RASSs monitored is suggested.**

Response: See the response to DTSC specific comment 9.

The complete data on percent cover of plants in monitored revegetation plots were provided in the "After Remediation (Year 5) Remedial Action Monitoring Report"; a table summarizing revegetation efforts at the site will be added to the draft final five-year periodic review assessment report. Please see the monitoring reports for a complete plant inventory and percent cover for all RASSs.

4. Comment: **Site wide climatic data (rainfall, air, inferred soil temperatures, wind speed, relative humidity) are missing from the report during the five-year period of monitoring.**

Response: Site-specific climatic data were not included in the monitoring program. Neither the Navy nor the regulatory agencies recommended collecting such data to support risk management decisions.

5. Comment: **Data tables for the following parameters should be included: 1. pH; 2. REDOX; 3. Salinity; 4. Conductivity; 5. Hardness; 6. TOC; 7. Percent Moisture.**

Response: Extensive presentation of physical data for the site has been provided in each of the annual post-remediation monitoring reports. A location-by-location presentation of physical data for each of the 5 years of postremediation monitoring is also provided in Tetra Tech EM Inc.'s (TtEMI) "After Remediation (Years 1 through 5) Monitoring Data Summary." A detailed presentation of physical data in the draft five-year periodic review assessment report was confined to data collected during the October 2000 sampling event, as this information had not been summarized elsewhere. However, the draft five-year periodic review assessment report does include extensive discussion of the sitewide physical data collected during the 5 years of monitoring in the context of evaluating the mobility and bioavailability of chemicals (please see Section 5.3 of Appendix G).

6. Comment: **A description of edaphic characteristics in terms of soil color, horizon configuration and general chemical characteristics for each RASS would be helpful.**

Response: This information was neither recommended in the monitoring plan nor collected during the 5 years of annual monitoring.

7. Comment: **<u>Table 73</u>: Board staff recommends adding a section discussing how for some metals in some areas of the litigation area, porewater concentration in sediments exceeded Ambient Water Quality Criteria (AWQC).**

Response: The Navy will add a brief discussion in the draft final baseline ecological risk assessment (Appendix G in the draft final five-year periodic review assessment report) about porewater concentrations that exceed ambient water quality criteria.

8. Comment: **<u>Page E-23 and Figure 50</u>: Board staff recommends improving the understanding of the sediment contaminant profile transported with incoming and outgoing cycles during spring tides of high amplitude at the Lost Slough outlet in Suisun Bay. Furthermore, the report indicates (page E-24): "turbidity of incoming tides typically exceeds the turbidity of outgoing tides by a significant margin". It is evident from looking at Figure 50 that there are tidal events when the outgoing tide was more turbid than the incoming tide. Please revise the report to indicate that in some instances outgoing tides are more turbid than incoming tides.**

Response: A complete discussion of long-term tidal turbidity monitoring at the mouth of Lost Slough, including statistical analysis of the data, appears in Section 6.3 of TtEMI's "After Remediation (Year 5) Remedial Action Monitoring Report." Review of figures illustrating the complete turbidity data collected over a three-month period during the wet season (Figure 6-13) reveals that the statement on page E-24 is accurate as stated; turbidity of incoming tides typically exceeds the turbidity of outgoing tides by a significant margin. Of the approximately 140 full tidal cycles that were monitored, turbidity in outgoing tides exceeded that of incoming tides nine times, and exceeded the turbidity of the incoming tide by a factor of two or more during one tidal cycle. A statement indicating that turbidity of some outgoing tides exceeded that of incoming tides will be added to Appendix E of the draft final five-year periodic review assessment report.

The Navy believes that the existing data demonstrates that the net direction of sediment transport is into the marsh, and that further evaluation of the direction of sediment transport is not necessary unless additional information is required for the evaluation of remedial alternatives during the supplemental feasibility phase.

The comments addressed below were received from CDFG in a letter dated October 16, 2001.

RESPONSES TO COMMENTS FROM CDFG

General Comments

1. Comment: **The DFG has reviewed the subject document and the EPA, TechLaw, and RWQCB comments on the subject document. The DFG concurs with the TechLaw recommendations for further action, and with the problem areas identified in the EPA comments. However, the EPA recommendation "that the Navy, the federal and state regulatory agencies, and the natural resource trustees establish a schedule of meetings to discuss the most efficient and effective response to ensure that Navy resources are directed at protecting human health and the environment." has much merit. The risk to ecological receptors continues to be unacceptable. We need to evaluate the lost ecological value caused by this risk in order to understand the relative value of further remediation. The DFG therefore, endorses EPA's recommendation for a measurement of "the current biotic potential (value) of the marsh as determined by comparison with an appropriate reference area."**

The subject document provides valuable information for ecological risk assessment in the litigation area. DFG requests that the Navy continue discussions with the regulators and the trustees to develop an effective response to the remaining ecological risks.

Response: Please see the responses to EPA general comments 1, 2, and 3.

References

PRC Environmental Management, Inc. "Draft Summary Report for the RASS 3 Hydrocarbon Site Investigation at Naval Weapons Station Concord."

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY, WEST
NAVAL FACILITIES ENGINEERING COMMAND
2001 JUNIPERO SERRA BOULEVARD, SUITE 600
DALY CITY, CALIFORNIA 94014-1976

IN REPLY REFER TO:

5090.3
Ser 052GAR/013
16 April 2002

From: Commanding Officer, Engineering Field Activity West, Naval Facilities Engineering Command

To: Distribution

Subj: FIVE-YEAR PERIODIC REVIEW ASSESSMENT FOR THE LITIGATION AREA, NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT, CONCORD, CA; RISK MANAGEMENT MEETING

Encl: (1) Meeting Minutes, Risk Management Meeting, Litigation Area, Naval Weapons Station, Seal Beach Detachment Concord, February 22, 2002

1. Enclosure (1) is forwarded for your information and record.

2. The enclosure reflects the general issues raised for discussion, the agreements reached and action items identified during the February 22, 2002, risk management meeting, for the Five-Year Periodic Review Assessment, at the Litigation Area at Naval Weapons Station Seal Beach Detachment Concord.

3. If there are any questions or comments regarding this correspondence, please contact the undersigned at (650) 746-7451.

GILBERT A. RIVERA
By Direction

Distribution:
U.S. Environmental Protection Agency, Region 9 (Attn: Phillip Ramsey)
U.S. Environmental Protection Agency, Region 9 (Attn: Sonce de Vries)
U.S. Fish and Wildlife Service (Attn: Jim Haas)
National Oceanic and Atmospheric Administration (Attn: Laurie Sullivan)
National Oceanic and Atmospheric Administration (Attn: Denise Klimas)
California Department of Toxic Substances Control, Region 1 (Attn: James Pinasco)
California Department of Toxic Substances Control, Region 1 (Attn: John Christopher)
California Department of Fish and Game (Attn: Jim Hardwick)
California Regional Water Quality Control Board, SFBAY (Attn: Laurent Meillier)
City of Concord (2) (Attn: James Forsberg)

5090.3
Ser 052GAR/013
16 April 2002

Subj: FIVE-YEAR PERIODIC REVIEW ASSESSMENT FOR THE LITIGATION AREA, NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT, CONCORD, CA; RISK MANAGEMENT MEETING

Distribution:
NWS SB Detachment Concord (Attn: Rudy Pontemayor)
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TtEMI (Attn: Ray Bienert)
TtEMI (Attn: Rik Lantz)
TtEMI (Attn: Richard Vernimen)
Tech Law, Inc. (Attn: Hilary Waites)

MEETING MINUTES
RISK MANAGEMENT MEETING
LITIGATION AREA
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD
February 22, 2002

These minutes reflect the general issues raised, agreements reached, and action items identified during the February 22, 2002, risk management meeting for the Litigation Area at Naval Weapons Station Seal Beach Detachment (SBD) Concord. The objective of the meeting was to discuss preliminary Navy responses and recommendations regarding ongoing concerns and comments from the regulatory and trustee agencies on the draft Five-Year Periodic Review Assessment Report for the Litigation Area (5-Year Review Report). The meeting took place from 10:00 a.m. to 3:00 p.m. at the Tetra Tech EM Inc. (TtEMI) offices in San Francisco, California.

The following people attended the meeting:

Gilbert Rivera	Naval Facilities Engineering Command, Engineering Field Activity West (EFA WEST)
Tony Tactay	EFA WEST
Rudy Pontemayor	Naval Weapons Station SBD Concord
Amado Andal	Naval Weapons Station SBD Concord
Jim Pinasco	California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC)
John Christopher	DTSC
Phillip Ramsey	U.S. Environmental Protection Agency (EPA)
Sonce de Vries	EPA and U.S. Fish and Wildlife Service (USFWS)
Laurent Meillier	Regional Water Quality Control Board (RWQCB)
Jim Hardwick	California Department of Fish and Game (CDFG)
Denise Klimas	National Oceanic and Atmospheric Administration (NOAA) and DTSC
Laurie Sullivan	NOAA
Ray Bienert	TtEMI
Joanna Canepa	TtEMI
Mary Gleason	TtEMI
Rik Lantz	TtEMI
Suzette Tay	TtEMI
Hilary Waites	Tech Law, Inc.

The meeting agenda is included as Attachment 1. The meeting handout is included as Attachment 2.

I. Introductions

Meeting participants introduced themselves to the group. Ms. Denise Klimas (NOAA) reported that she was phasing into the role of Ms. Laurie Sullivan (NOAA) on projects at the Naval Weapons Station SBD Concord. She explained that she would begin assuming a dual role of providing technical support to both DTSC and NOAA. She commented that her position was similar to that of Ms. Sonce de Vries, who provides technical support to both EPA and USFWS.

Mr. Phillip Ramsey (EPA) asked whether there would be any representatives from USFWS involved in the risk management discussion. Ms. Mary Gleason (TtEMI) said that she had sent the agenda and discussion materials for the meeting to Ms. Charlene Hall and Mr. Jim Haas (USFWS) but had not heard from them. Ms. de Vries indicated that Ms. Hall was immersed in Natural Resources Damage Assessment (NRDA) issues and would not be involved in the discussions. However, she stated that Mr. Haas planned to become more involved in the future.

After some discussion about the document schedule, the group agreed that (1) the Navy would submit its responses to agency comments (RTC) on March 1, 2002; (2) another risk management meeting would be held after the submittal; and (3) the draft final 5-Year Review Report would be submitted following the subsequent risk management meeting, likely after March 31.

Mr. Gil Rivera (EFA WEST) reported that the Navy's current contract with TtEMI would be ending in September 2002. He said that EFA WEST planned to use other contract vehicles to allow TtEMI to continue working at Naval Weapons Station SBD Concord. He assured the group that he did not expect any delay in the work.

Mr. Ramsey announced that EPA's Office of Solid Waste and Emergency Response had recently issued a new guidance on the principles of managing risk and hazardous waste sites on February 12, 2002. He stated that several of his comments on the 5-Year Review Report would be based on the new guidance.

II. General Issues

Ms. Gleason presented the agenda for the meeting and a handout that contained a preliminary version of the Navy's RTCs. She explained that the agenda items were developed based on agency comments.

A. Wetland Values Assessment

The agencies have requested that the Navy conduct a wetland values assessment to assist in decision-making. Ms. Gleason stated that the Navy agreed with the regulatory agencies that understanding the value of the wetland in the Litigation Area was important to making risk management decisions. However, she asked the agencies to clarify the types of data that should be collected and the kinds of decisions that would be made, based on a data quality objectives (DQO) approach. She said that the Navy felt that sufficient information already existed to assess the value of the wetland.

Ms. Sullivan explained that the primary concern with regard to the wetland was whether it was too valuable to risk damaging it during cleanup. She suggested conducting a habitat equivalency analysis and considering mitigation measures if any cleanup was proposed. She acknowledged that a more detailed discussion of these approaches was required. Mr. Rivera requested that the word "mitigation" be avoided in the 5-Year Review Report, as the Navy's Installation Restoration Program preference is remediation.

Ms. de Vries commented that while the Navy had determined that risk existed at the wetland site, it had not proposed any approach to risk management. She added that if the Navy agreed that the wetland was "valuable," then the discussion should perhaps shift to developing alternatives for dealing with the risk, rendering the wetland values assessment moot.

Ms. Gleason reported that the Navy was proposing a post five-year review supplemental feasibility study that would include a cost-benefit analysis for several portions of the Litigation Area.

Mr. Ramsey commented that he appreciated hearing stronger wording during the discussion than was presented in the handout. He said that discussion of a supplemental feasibility study had been on the table since 2000, and it was critical that the Navy was finally taking that step.

B. Neighboring Sources

The Navy and agencies discussed concerns that upgradient sources are still impacting the Litigation Area. Ms. Gleason emphasized the importance of addressing upgradient sources on neighboring properties before remediating any downgradient Navy property. She said that while the Navy was willing to continue discussing alternatives that could be implemented to address problems on Navy property, upgradient sources had to be addressed to ensure that Navy property would not be re-contaminated.

Mr. Jim Pinasco (DTSC) stated that his agency was stabilizing the spoil pile at the Chemical & Pigment Company (CPC) site as part of an emergency action. He added that DTSC would attempt to identify potential responsible parties (PRP) before considering long-term remediation. Mr. Ramsey emphasized the importance of the Navy examining the consent decrees that it has established with neighboring companies to determine the available legal alternatives.

C. Groundwater

RWQCB has recommended additional groundwater sampling at all sites. Ms. Gleason said that the Navy acknowledged that groundwater in the Litigation Area had not been sampled since 1996, and that it was willing to conduct another complete round of sampling. Mr. Laurent Meillier (RWQCB) commented that one additional round of groundwater sampling might not be sufficient.

Mr. Rik Lantz (TtEMI) reported that the historical groundwater database for the Litigation Area contained data from quarterly groundwater sampling events over a 4-year period. He said that no seasonal variation was observed in the data. Ms. Gleason added that agencies had agreed to drop groundwater sampling from the Litigation Area monitoring program because a sufficient number of groundwater samples had already been collected that indicated no problem. However, she acknowledged that it had been more than 5 years since the last round of sampling. Mr. Lantz indicated that groundwater sampling data collected in 1996 showed a substantial decrease in contaminants after the remedial action.

Mr. Meillier stated that more than one additional round of groundwater sampling might be required because the interaction between surface water and groundwater was not yet clearly understood. Mr. Lantz asked whether RWQCB could propose any specific methodologies for assessing surface-to-groundwater interactions. Mr. Meillier suggested using tracers or applying a mass balance approach.

Ms. Gleason summarized by stating that the Navy and agencies agreed to continue discussing the technical issues and data gaps related to groundwater. She indicated, however, that further discussion would be deferred to a separate meeting regarding the more specific sampling plans to address groundwater issues in the Litigation Area.

D. Monitoring

In their comments, DTSC recommended additional monitoring and provided a list of items suggested for annual and 5-year monitoring. Ms. Gleason stated that the Navy does not intend to initiate a new monitoring program at this time. She explained that the focus of this year would be to complete the 5-Year Review Report and reach an agreement with the agencies on what the "next steps" would be, including conducting focused studies to address outstanding issues. She stated however, that the Navy was willing to consider focused monitoring every 5 years. Mr. John Christopher (DTSC) commented that he would be satisfied with focused studies conducted in the context of a supplemental feasibility study. Mr. Pinasco agreed.

Ms. Gleason summarized by stating that the Navy and agencies agreed to defer the annual monitoring discussion until a later date. She indicated that in the meantime, the Navy would work toward addressing data gaps in the supplemental feasibility study.

III. RASS 3

Ms. Gleason stated that the areas in RASS 3 would be discussed next; topics for discussion were organized from upgradient to downgradient.

A. Chemical & Pigment Company

The Navy and agencies discussed concerns regarding CPC acting as an ongoing contaminant source due to the presence of an uncovered stockpile of contaminated soil and high levels of metals in groundwater at the CPC site that borders Nichols Creek. Ms. Gleason reported that because of a lack of data on soil contamination beyond the edge of the CPC stockpile, the extent of soil contamination was unknown; groundwater at the CPC site is known to be contaminated. She said that Mr. Rivera was drafting a letter to DTSC to request the agency's cooperation and assistance in resolving the issue. She added that the Navy's environmental counsel was also reviewing the consent decree associated with the site.

Mr. Rivera reported that the Navy was establishing an office specifically to investigate PRPs, and that he had requested help from that office regarding the CPC site. Mr. Ramsey offered to participate in any PRP meetings and provide assistance to the investigative efforts.

Ms. Hilary Waites (Tech Law, Inc.) asked whether a separate meeting would be held to discuss the CPC study described in the meeting handout, specifically with regard to the Navy's plan to conduct a small focused study to evaluate groundwater-surface water interactions at the CPC-Navy property boundary. Ms. Gleason said that a separate meeting would be helpful to discuss the Navy's proposed plans for sampling at the site. She stated that an expedited review of a FSP by the agencies may be needed in the future. She added that there might be challenges with regard to access to the CPC site or adjacent railroad easements that may confound the study design.

B. Railroad Erosional Areas

The Navy and agencies discussed concerns about extensive erosion observed along railroad right-of-ways in RASS 3. Based on a study conducted in 2000, Mr. Lantz developed a map showing the major areas of erosion in RASS 3. Ms. Gleason reported that the two largest areas of erosion were on railroad property. She said that the Navy planned to write a letter to the railroad companies – specifically Sacramento Northern and Atchison, Topeka & Santa Fe (AT&SF) – to alert them regarding the erosion problem and request their assistance. She added that the Navy had established consent decrees with these companies as well; these decrees would also require review by Navy legal counsel.

C. RASS 3 Railroad Area

The Navy and agencies discussed concerns that polychlorinated biphenyl (PCB) contamination along the railroad track in RASS 3 has not been adequately characterized. Ms. Gleason said that the Navy had conducted a full suite of analyses on samples collected at the site in 1995 and 1996. She reported that 1.5 parts per million (ppm) of PCBs was detected in samples from the edge of the railroad right-of-way on Navy property. She stated that the ecological risk assessment conducted for the site concluded that no significant risk to receptors was present. However, the Navy acknowledged that a spatial data gap existed along part of the railroad right-of-way in RASS 3. Ms. Gleason emphasized that railroad operations were likely the source of PCB contamination, because there were no known Navy sources of PCBs. She stated that the Navy was willing to collect additional soil samples and would confer with the agencies during development of the sampling plans.

D. Nichols Creek and RASS 3 (Unit 13)

The Navy and agencies discussed concerns about uncontrolled erosion along Nichols Creek that may be mobilizing historical and current sources of contamination. Ms. Gleason reported that the Navy's primary concern was associated with the potential migration of contamination from RASS 3 to RASS 1. She said that the Navy hoped to address the potential migration of contaminants from upgradient sources through discussions with neighboring property owners.

Mr. Christopher expressed concern about the potential for metals uptake by aquatic organisms in Nichols Creek. Ms. Gleason said that the Navy had conducted studies of organisms found in ponded areas in RASS 3 and that no significant bioaccumulation was observed. She added that food chain modeling did not show risk in plant or rodent tissue data collected at the site. She said that the supplemental feasibility study would consider alternatives for reducing the potential for migration of contaminants from the site.

IV. RASS 1

A. General Chemical Facility

The Navy and agencies discussed concerns that the General Chemical facility may be an ongoing source of contaminants based on information gathered during the file review, observations of distressed vegetation in the remediated area of RASS 1, and observations of repeated railcar spills of white aluminum-based powder along the railroad track separating RASS 1 and RASS 3.

Ms. Gleason observed that there were significant groundwater problems at the General Chemical facility site, including pH measurements as low as 2. She reminded the group that during a site visit in July 2001, she and Phillip Ramsey had noticed an area of distressed vegetation along the berm. She said that the Navy proposed to conduct soil and grab surface water and groundwater sampling on the Navy side of the berm to determine whether any contamination was present. She added that TtEMI would examine the files again to identify more recent groundwater data that the General Chemical facility had collected for ongoing studies on their property.

Mr. Lantz reported that existing data did not suggest that there was potential groundwater contamination at the site. He explained that the Navy already had four wells along the Navy side of the berm and that, based on historical data and recent data from 1996, no contamination was present. He added that groundwater velocity was relatively slow between the upgradient General Chemical facility and the downgradient Navy property.

Ms. Gleason also discussed past observations of a white powder spill from the railroad cars, which according to Mr. Meillier, who had taken a sample for analysis, contained 13 percent aluminum. Ms. Gleason stated that a baseline risk assessment previously conducted at the site had revealed elevated concentrations of aluminum in surface water at the Litigation Area. She commented that the white powder from the railroad cars was the probable source of the elevated aluminum. She said that the issue will be directed to AT&SF, which owns the railroad spur on which the contaminated railroad cars were located.

B. Marsh Surface West of RASS 1 Active Remediation Area

EPA and RWQCB have expressed concerns about risk to special status species from contaminants remaining in the marsh surface. Ms. Gleason stated that the ecological risk assessment identified four locations with arsenic concentrations that posed a potential risk to the salt marsh harvest mouse. However, she reported that x-ray fluorescence (XRF) studies, which examined the vertical profiles of the contamination, led to a different conclusion. She explained that the XRF studies showed a horizon of contamination at about 3 to 5 inches below ground surface (bgs) that was evidence of a historical spill (estimated at 50 years ago) and steady accretion of cleaner sediment. Ms. Gleason said that the risk estimate for the salt marsh harvest mouse was likely an overestimate because the mouse does not burrow and would not be exposed to the high concentrations for incidental soil ingestion used in the food chain model. She added that because the high concentrations occurred only at four locations and was an overestimate, the risk to the mouse did not justify a cleanup of the area.

Mr. Christopher stated that the only justification for cleanup at the site would be if arsenic concentrates in portions of the plant that the mouse eats. Ms. Gleason responded that significant accumulation had not been observed in pickleweed collected from the highest arsenic concentration areas in the marsh.

Ms. Gleason stated that the Navy was not proposing to conduct a supplemental feasibility study for the marsh surface, except as related to potential impacts to the marsh surface as a by-product of activities in other areas addressed by the supplemental feasibility study (for example, driving trucks through the marsh to reach another site).

Mr. Ray Bienert (TtEMI) referred to an agency comment that asked for more information concerning the characterization of spatial and temporal variability and the identification of hot spots. He explained that he examined pooled data across the site and identified hotspots based on an operational definition of statistical outliers. He said that when the Navy was considering how to best represent risk footprints for different receptor groups, the main emphasis was on presenting the results for multiple lines of evidence. He stated that looking at risk based only on a chemical hot spot analysis versus the weight of evidence approach used in the five-year report resulted in the same basic conclusions in terms of identifying areas of potential concern. Mr. Bienert used maps to present to the group an overlay of the hotspot analysis and the ecological risk footprint.

C. Small Arm of Lost Slough (Unit 11)

EPA and RWQCB have expressed concerns about risk to aquatic invertebrates and the California Black Rail at Unit 11 in RASS 1. Ms. Gleason stated that, based on the hydrology of the site, this portion of Lost Slough had historically been a sink for contamination from Nichols Creek. She noted that there were high levels of zinc that would result in unacceptable risks to fish and invertebrates. She said that the Navy recognized that the slough provided important habitat and proposed the supplemental feasibility study to consider cleanup alternatives.

Ms. Gleason stated there were concerns about the migration of contaminants from RASS 3 to RASS 1. She asserted that the Navy would prefer not to conduct additional actions in RASS 1 until it was sure that RASS 3 was not contributing additional contamination. She also said that, as the farthest downstream site, Unit 11 would likely be last in terms of implementation of alternatives.

D. Mosquito Ditches (Unit 7) in RASS 1

EPA and RWQCB have expressed concerns about contaminant transport in the mosquito ditches in the southeastern part of RASS 1. Ms. Gleason stated that, based on XRF and ditch profile studies, the Navy acknowledged that there was concern about contaminant migration. However, she added that the ditches were not natural features, were anoxic and not providing much habitat, and were slowly filling in and shrinking. She said that the concern was not so much related to ecological risk as it was to the contaminant transport features of the ditches. To assist in determining a way to reduce potential contaminant transport via the ditches, the Navy proposed conducting the supplemental feasibility study.

Mr. Christopher commented that perhaps the ditches should be filled in if they did not provide significant habitat. Ms. Gleason responded that the Navy would consider that option in the supplemental feasibility study and evaluate the impacts. She stated that the Mosquito Control District was applying an active approach to filling up some ditches in a pilot study; results of those efforts could guide similar work at the Litigation Area. Ms. de Vries commented that filling the ditches could potentially impact other areas hydrologically. Ms. Gleason suggested that there could be more ponding on the marsh surface because the water would not drain as easily without the ditches. The group agreed that hydrological and ecological impacts of filling the ditches would have to be evaluated.

E. Groundwater-Surface Water Mixing in RASS 1

EPA has expressed concerns about contaminated groundwater from neighboring properties and recommended installing groundwater wells along the shoreline of Suisun Bay. Mr. Lantz stated that installing wells along the shoreline was technically impractical, primarily because (1) the shoreline was inaccessible by drill rigs and (2) it would be difficult to maintain a stable screened interval there. Ms. Waites stated that the wells did not have to be along the shoreline, as long as they were within the equilibrium zone between the groundwater and surface water. She explained that the primary issue was what the groundwater was contributing to the wetland area. Ms. Gleason stated that sampling data for the wells that were currently in place did not show any contamination. Ms. Waites noted that they had been sampled in 1996 and that the closest well to RASS 1 was adjacent to the General Chemical facility. She stated that not much is known about groundwater flow between the General Chemical facility and the remediated area.

All agreed that discussion would continue at another meeting focused on the specifics of the Navy plans. The group agreed that focusing additional effort along the berm with General Chemical and resampling existing wells would be the best approach. In addition, the Navy would determine whether any contamination was present in the remediated area of RASS 1 before involving the neighbors.

V. RASS 4

A. RASS 4 Protectiveness and Characterization

EPA and RWQCB have indicated that the remedy for RASS 4 is not protective and that the site is not sufficiently characterized. Ms. Gleason asked for the agencies' specific concerns and introduced a series of maps to support the discussion.

Mr. Ramsey stated that his primary concern related to how the site was historically used for disposal. He expressed concern about an ash-like material that he and Ms. de Vries had observed on a road in RASS 4. He asked whether people could be entering RASS 4 and dumping coke on the site. Mr. Lantz explained that, based on his examination of aerial photographs of the site, the illegal dumping associated with the site primarily involved trash, sofas, and other household goods. He did not observe any unusual piles of soil or possible coke material. Mr. Lantz added that, during sampling in the creek in RASS 3, he had observed lithified material that may have resembled the ash-like substance described by Mr. Ramsey. He suggested that the material was associated with bedrock. Ms. de Vries stated that the ash-like material resembled fly ash from power plants. She added that if the material was indeed fly ash, it would raise concerns about heavy metals and radioactivity. She acknowledged that there were power plants in the area and fly ash could have potentially been dumped there. The Navy agreed to consider the collocation of the existing data with the lithified material and to consider the matter further.

Mr. Ramsey also asked about the impact of local the Bay Point housing development on the wetland in RASS 4. Ms. Gleason reported that chlordane had been observed in the wetland, but it was not attributed to a Navy source and was likely from residential use in the neighborhood.

B. Access and Security Issues

The Navy and agencies have observed evidence of trespass in RASS 4. Ms. Gleason explained that the Navy would develop a security plan for the site, and that Mr. Rudy Pontemayor (Naval Weapons Station SBD Concord) would coordinate with the facility to implement it. Mr. Pontemayor reported that although there was a fenced area around RASS 4 and the gate to the area had a padlock, people could still walk onto Navy property on either side of the fence. Mr. Ramsey observed that a person could easily take an off-road vehicle out to the road leading to CPC and General Chemical and illegally dump trash. He added that a berm had been created on that road as a ramp for off-road vehicles.

C. RASS 4 Fire

EPA has commented on the lack of notification regarding the fire. The Navy and agency representatives have received comments from the restoration advisory board regarding the fire. Ms. Gleason reported that during her recent visit to RASS 4 after the fire, she observed that some of the coyote bushes were resprouting. She said that she did not think that the fire was ecologically destructive and may have benefited native plants. She stated that the fire eliminated thistles and reintroduced grasses but that these non-native plants would likely return.

Mr. Ramsey asked about speculations that an eagle had started the fire. Ms. Joanna Canepa (TtEMI) clarified that, according to the Navy public affairs officer, the fire in RASS 4 had been ignited by "misled youths." She said that the eagle was associated with another fire at Naval Weapons Station SBD Concord.

VI. Review Action Items and Schedule Next Meeting

Action Items

Mr. Rivera will send Mr. Christopher a copy of the Navy policy on cleanup of contaminated sediments.

Next Meeting

The next risk management meeting will take place on Wednesday, March 27, 2002, at the TtEMI offices in San Francisco, California. The purpose of the meeting will be to discuss more specifics and finalize the recommendations that will appear in the draft final version of the five-year review report.

ATTACHMENT 1

AGENDA
RISK MANAGEMENT MEETING
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
LITIGATION AREA SITES, NWSSB DETACHMENT CONCORD
Friday, February 22, 2002
10:00 AM - 3:00 PM
Tetra Tech EMI, Large Conference Room
135 Main Street, Suite 1800
San Francisco

Objective: Discuss preliminary Navy responses and recommendations regarding ongoing concerns and comments from the regulatory and trustee agencies on the draft Five-Year Periodic Review Assessment Report for the Litigation Area.

I. Introductions (10:00 - 10:10)

II. General Issues (10:10 – 11:10)

- Wetland values assessment
- Neighboring sources – general concerns
- Groundwater
- Monitoring

III. RASS 3 (11:10 - 12:00)

- Chemical Pigment Company
- Railroad erosional areas
- RASS 3 railroad area (PCBs)
- Nichols Creek and RASS 3 (Unit 13)

LUNCH (get lunch and bring it back to meeting, 12:00 - 12:30)

IV. RASS 1 (12:30 - 2:00)

- General Chemical facility
- Marsh surface west of RASS 1 active remediation area
- Small arm of Lost Slough (Unit 11)
- Mosquito ditches (Unit 7) in RASS 1
- Groundwater-surface water mixing in RASS 1

V. RASS 4 (2:00 - 2:45)

- RASS 4 protectiveness and characterization
- Access and security issues
- RASS 4 fire

VI. REVIEW ACTION ITEMS AND SCHEDULE NEXT MEETING (2:45 - 3:00)

ATTACHMENT 2

HANDOUT
RISK MANAGEMENT MEETING
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
LITIGATION AREA,
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD
February 22, 2002

The Navy will submit formal responses to comments from the regulatory and trustee agencies regarding the draft Five Year Periodic Review Assessment, Litigation Area report on March 1, 2002. This handout presents preliminary recommendations from the Navy on major issues identified in the Navy five year review report, in agency comments on that report, or based on observations made during recent site visits to the remedial action subsites (RASS). The purpose of this handout is to provide the agencies with a preview of Navy recommendations on issues identified by the agencies and the Navy prior to the February 22, 2002 Risk Management meeting where these issues will be discussed.

GENERAL ISSUES:

1) Wetland values assessment: Agencies would like Navy to conduct a wetland values assessment to assist decision-making

- The Navy agrees that the value of the RASS 1 marsh is integral to the issue of making decisions on whether the risk from remaining contaminants warrants additional actions at the site since remedial actions are generally very destructive. The Navy maintains that sufficient information is available from the many years of ecological monitoring to characterize the value of the Litigation Area wetland without putting resources into additional study. The Navy does not agree that a single reference site comparison would be sufficient to assess value.
- The Navy agrees to discuss this issue further with the agencies but requests that the agencies better justify the need for a wetland values assessment by providing the Navy with a Data Quality Objective (DQO) presentation on what data would be collected, how the information would be used to make decisions, and what reference sites would be suitable for comparison to the Litigation Area. Specifically, the Navy would need to know how the results of the values assessment would be used to make decisions on the need for additional actions.

2) Neighboring sources: Both the Navy and agencies have concerns that upgradient sources are still impacting the Litigation Area

- The Navy maintains its position that upgradient offsite sources need to be addressed and removed before any additional downgradient remediation on Navy property.
- The Navy is willing to continue discussion of downgradient areas of concern on Navy property with the agencies in the interim period while neighboring sources are addressed.
- The Navy is willing to consider conducting some limited studies on its property to further assess the impact of neighboring sources on Navy property (see specifics below).

3) Groundwater: Regional Water Quality Control Board (RWQCB) recommended additional groundwater sampling at all sites

- The Navy acknowledges that groundwater has not been sampled since 1996. The Navy is willing to consider conducting one round of groundwater sampling for metals in all existing groundwater wells to provide more current information on groundwater quality. In addition, some new wells may be needed in areas next to neighboring sources to address ongoing concerns about migration from offsite sources. Groundwater data will be contoured.

4) Monitoring: Department of Toxic Substances Control (DTSC) recommended additional monitoring and provided a list of items suggested for annual and five-year monitoring

- At this time, the Navy is not planning to conduct annual monitoring. As there are still outstanding issues of concern, the Navy is willing to consider conducting focused specific studies to address specific objectives or data gaps while decisions are being made about the need for additional action at the site.
- The Navy is willing to consider conducting limited monitoring at five-year intervals and would develop a new monitoring plan before the next five-year monitoring event. Any future monitoring plan would have very specific objectives and would follow the DQO process, as discussed in the draft five-year review report.

RASS 3:

5) Chemical Pigment Company (CPC): The Navy and agencies have significant concerns about CPC as an ongoing source due to the presence of an uncovered stockpile of contaminated soil and high levels of metals in groundwater at the CPC site that borders Nichols Creek

- The Navy will send letters of concern regarding the contaminated stockpile and contaminated groundwater to agencies and the property owner.
- The Navy will meet with agency remedial project managers (RPMs) responsible for the CPC site to make sure that the Navy's concerns are communicated.
- The Navy is willing to consider conducting a small focused study to evaluate groundwater – surface water interactions at the CPC-Navy property boundary. Lithologic relationships between CPC and the Litigation Area are not well understood, especially with regards to a perched groundwater zone reported at CPC. The objectives of the study would be to: (1) establish whether a groundwater/surface water preferential flow pathway exists by evaluating lithology at the northwest corner of the CPC property; (2) create geologic cross-sections that extend across the site boundary onto CPC using existing well logs from "Hydrogeologic Assessment Report for an Impoundment at 600 Nichols Road, Pittsburg, CA" Environmental Solutions, Inc. Dec. 31, 1987, and if necessary, installing an additional monitoring well on Navy property near CPC to provide detailed lithologic information in the critical area between CPC and Nichols Creek and to assess contaminant concentrations migrating onto Navy property; and (3) assess the recharge/discharge relationship between CPC and Nichols Creek by obtaining concurrent surface water/groundwater elevations and elevations of the base of Nichols Creek.

- The Navy maintains its position that upgradient and non-Navy sources at CPC need to be addressed and removed before any additional downgradient remediation on Navy property in RASS 3 or RASS 1.

6) Railroad erosional areas: The Navy and agencies have concerns about extensive erosion observed along railroad right of ways in RASS 3.

- The Navy will send letters of concern regarding erosion of metals contaminated soil onto Navy property to regulatory agencies and property owner(s).
- The Navy will meet with agency RPMs responsible for the railroad sites to make sure that the Navy's concerns are communicated.
- The Navy maintains its position that upgradient non-Navy sources in the railroad right of ways need to be addressed and removed before any additional downgradient remediation in RASS 3 or RASS 1.

7) RASS 3 Railroad area [polychlorinated biphenyls (PCBs)]: The EPA has concerns that PCB contamination along the railroad track in RASS 3 has not been adequately characterized.

- The Navy is willing to consider conducting limited sampling of PCBs on Navy property along the railroad track in RASS 3.

8) Nichols Creek and RASS 3 (unit 13): The Navy and agencies are concerned about uncontrolled erosion along Nichols Creek that may be mobilizing historic and ongoing sources of contamination.

- The Navy is concerned about soil erosion along Nichols Creek and the potential for mobilization of contaminants to the wetland in RASS 1. Based on migration concerns, additional actions to reduce erosion potential in RASS 3 should be considered. The Navy believes that the best process for evaluating additional actions is through a supplemental feasibility study that would evaluate alternatives to reduce contaminant transport.
- The Navy maintains its position that upgradient offsite sources need to be addressed and removed or controlled before any additional downgradient remediation on Navy property in RASS 3.

RASS 1:

9) General Chemical facility: The Navy and agencies have significant concerns that the General Chemical facility may be an ongoing source of contaminants based on the file review, observations of distressed vegetation in the remediated area of RASS 1, and observations of repeated railcar spills of white aluminum-based powder along the railroad track separating RASS 1 and RASS 3.

- The Navy will send letters of concern regarding contaminated groundwater and railcar spills to agencies and property owner(s).
- The Navy will meet with agency RPMs responsible for the General Chemical facility site(s) to make sure that the Navy's concerns are communicated.

- The Navy is willing to consider conducting a small focused study to evaluate groundwater and soil contamination levels along the berm in the area of distressed vegetation. Lithologic relationships between General Chemical and the Litigation Area are not well understood. The objective of the study will be to: (1) create geologic cross-sections that extend across the site boundary onto General Chemical using existing well logs from "Technical Memorandum, Fate and Transport Evaluation: Metals in Groundwater, General Chemical Corporation Bay Point Works Facility." (Montgomery Watson 2000) and "Work Plan for On-site Vertical Gradient and Chemistry Evaluation, General Chemical Corporation Bay Point Works Facility."(Montgomery Watson 2000) and (2) document the presence or absence of new contamination in the remediated portion of RASS 1 along the berm separating the two properties in the area of distressed vegetation.
- The Navy maintains its position that upgradient non-Navy sources at the General Chemical facility and on their railroad spurs need to be addressed and removed or controlled before any additional downgradient remediation on Navy property in RASS 1.

10) The marsh surface just west of the RASS 1 actively remediated area: The EPA and RWQCB are concerned about risk to special status species from contaminants remaining in the marsh surface.

- The Navy does not believe that the residual contamination in the marsh surface poses a risk that warrants additional action. This conclusion is based on the results of the baseline ecological risk assessment and the evaluation of migration potential. While a few locations posed some risk to the salt marsh harvest mouse based on maximum concentrations of arsenic in six inch composite cores; based on vertical profiles of contaminants, these concentrations are not found at the surface of the soil where mice would be exposed but are buried under several inches of cleaner soil that has accreted on the marsh since the historic spills. The presence of a dense layer of vegetation prevents lateral migration of contaminants in the area. The Navy believes that the impacts of additional remediation over a wide area of the southeastern marsh surface in RASS 1 would outweigh any residual risk reduction that could be obtained.
- The Navy is willing to consider conducting focused and limited five-year monitoring of this area since contamination was left in place.

11) The small arm of Lost Slough (unit 11): The EPA and RWQCB are concerned about risk to aquatic invertebrates and the black rail in this side slough in RASS 1.

- The Navy acknowledges some risk to aquatic invertebrates and fish and black rails and the potential for mobilization of contaminants within the Unit 11 slough in RASS 1. Based on a weight of evidence process that shows ecological risk, concerns about migration potential, and the high concentrations of metals present, additional actions to reduce ecological risk in the small arm of Lost Slough (Unit 11) in RASS 1 should be considered.
- The Navy believes that the best process for evaluating alternative actions is through a supplemental feasibility study that would evaluate remedial alternatives and whether additional remedial actions would reduce risk enough to offset the adverse impacts from the associated habitat destruction. The ecological and economic cost and benefit of remedial alternatives would be evaluated within the context of the ecological value of the wetland in RASS 1.

- Since the Unit 11 slough has acted as a "sink" for contaminants migrating from upgradient sources through Nichols Creek, the Navy maintains its position that upgradient onsite and offsite sources need to be addressed and removed before any additional downgradient remediation is implemented in the slough in RASS 1.

12) The mosquito ditches (unit 7) in RASS 1: The EPA and RWQCB are concerned about contaminant transport in the mosquito ditches in the southeastern part of RASS 1.

- The Navy acknowledges some potential for mobilization of contaminants within the mosquito ditches in Unit 7 in RASS 1 that have high concentrations of metals. These ditches are not natural features and do not provide important habitat. Based on concerns about the ditches acting as transport pathways, alternatives to reduce contaminant mobility in the ditches in Unit 7 should be considered.
- The Navy believes that the best process for evaluating alternative is through a supplemental feasibility study that would evaluate remedial alternatives and whether additional remedial actions would reduce contaminant transport enough to offset the adverse impacts from the associated habitat destruction. The ecological and economic cost and benefit of remedial alternatives would be evaluated within the context of the ecological value of the surrounding wetland in RASS 1 that would be impacted by remedial actions focused on ditches.

13) The potential groundwater/surface water mixing zone in RASS 1: The EPA is concerned about contaminated groundwater from neighboring properties and recommended installing groundwater wells along the shoreline of Suisun Bay.

- The Navy is also concerned about contaminated groundwater at the General Chemical facility, especially in light of the recent observations of distressed vegetation along the berm separating that facility from Navy property.
- As discussed in items #3 and #9 above, the Navy is willing to consider resampling all existing wells in the RASSs and conducting a focused study to evaluate groundwater and soil contamination in the area of distressed vegetation along the boundary with General Chemical.
- The Navy does not plan to install groundwater monitoring wells along the shoreline for several reasons. First, the shoreline is more than 1000 feet from the closest contaminated soil in RASS 1 and, with the fine grain properties slow flow rate of groundwater through Bay Muds (on the order of 3 feet per year), it would take decades or centuries for contaminants to reach Suisun Bay through the marsh surface soils. The abundant organic material and clays in the subsurface offer significant retardation potential, that would be expected to further slow the migration of dissolved metals in groundwater and to immobilize a significant fraction of dissolved metals. Second, the shoreline is inaccessible to drill rigs which means that wells would have to be installed by hand; it is not feasible to properly install and develop monitoring wells by hand in this area.

RASS 4:

14) RASS 4 protectiveness and site characterization: EPA and RWQCB indicated that the remedy for RASS 4 was not protective and the site was not sufficiently characterized

- The agencies approved all sampling plans in this area during past investigations. The remedial investigation sampling locations were based on site history. The monitoring sampling locations were selected using a stratified random design as agreed to by the regulatory and trustee agencies. The baseline ecological risk assessment concluded that there was no significant risk to ecological receptors in RASS 4. The Navy would like further clarification from the agencies on what part of the site requires further characterization and why the agencies do not consider the remedy at RASS 4 to be protective.

15) Access and security issues: Navy and agencies observed evidence of trespass in RASS 4.

- The Navy will consider developing a security plan with base security personnel to ensure adequate patrols and secured locks on RASS 4 gates.
- The Navy will consider installing complete fencing of perimeter of RASS 4 (along railroad tracks on north side of RASS 4) to prevent trespass.
- The Navy will consider posting signs warning of presence of hazardous waste in all RASSs.

16) RASS 4 fire: EPA commented on lack of notification of the fire; Navy and agency representatives have received comments from the restoration advisory board on the fire.

- The Navy will work to ensure closer communication with the agencies on future events that affect environmental sites at the installation.
- The Navy will monitor resprouting of coyote bushes and grasses through spring to assess ecological impact of the fire in the revegetated area.

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY, WEST
NAVAL FACILITIES ENGINEERING COMMAND
2001 JUNIPERO SERRA BOULEVARD, SUITE 600
DALY CITY, CALIFORNIA 94014-1976

IN REPLY REFER TO:
5090.3
Ser 052GAR/012
16 April 2002

From: Commanding Officer, Engineering Field Activity West, Naval Facilities Engineering Command

To: Distribution

Subj: FIVE-YEAR PERIODIC REVIEW ASSESSMENT FOR THE LITIGATION AREA, NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT, CONCORD, CA; RISK MANAGEMENT MEETING

Encl: (1) Meeting Minutes, Risk Management Meeting, Five-Year Periodic Review Assessment, Litigation Area Sites, Naval Weapons Station, Seal Beach Detachment Concord, March 27, 2002

1. Enclosure (1) is forwarded for your information and record.

2. The enclosure reflects the general issues raised for discussion and the agreements reached during the March 27, 2002, risk management meeting, for the Five-Year Periodic Review Assessment, at the Litigation Area at Naval Weapons Station Seal Beach Detachment Concord.

3. If there are any questions or comments regarding this correspondence, please contact the undersigned at (650) 746-7451.

GILBERT A. RIVERA
By Direction

Distribution:
U.S. Environmental Protection Agency, Region 9 (Attn: Phillip Ramsey)
U.S. Environmental Protection Agency, Region 9 (Attn: Sonce de Vries)
U.S. Fish and Wildlife Service (Attn: Jim Haas)
National Oceanic and Atmospheric Administration (Attn: Laurie Sullivan)
National Oceanic and Atmospheric Administration (Attn: Denise Klimas)
California Department of Toxic Substances Control, Region 1 (Attn: James Pinasco)
California Department of Toxic Substances Control, Region 1 (Attn: John Christopher)
California Department of Fish and Game (Attn: Jim Hardwick)
California Regional Water Quality Control Board, SFBAY (Attn: Laurent Meillier)
City of Concord (2) (Attn: James Forsberg)

5090.3
Ser 052GAR/012
16 April 2002

Subj: FIVE-YEAR PERIODIC REVIEW ASSESSMENT FOR THE LITIGATION AREA, NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT, CONCORD, CA; RISK MANAGEMENT MEETING

Distribution:
NWS SB Detachment Concord (Attn: Rudy Pontemayor)
NWS SB Detachment Concord (Attn: Amado Andal)
Restoration Advisory Board Co-Chair (Attn: Marcus O'Connell)

Copy to:
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RAB Member Dean McLeod
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RAB Member Mary Lou Williams
TtEMI (Attn: Mary Gleason)
TtEMI (Attn: Ray Bienert)
TtEMI (Attn: Rik Lantz)
TtEMI (Attn: Richard Vernimen)
Tech Law, Inc. (Attn: Hilary Waites)

MEETING MINUTES
RISK MANAGEMENT MEETING
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
LITIGATION AREA SITES
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD
March 27, 2002

These minutes reflect the general issues raised, agreements reached, and action items identified during the March 27, 2002, risk management meeting for the Five-Year Periodic Review Assessment at the Litigation Area at Naval Weapons Station Seal Beach Detachment (SBD) Concord. The objectives of the meeting were to discuss and receive regulatory and trustee agency input on: (1) the Navy's response-to-comments document submitted February 28, 2002, (2) any human health risk issues or concerns, (3) the Navy's proposed plan for additional sampling efforts, and (4) the Navy's proposed scope for the post-five-year review supplemental feasibility studies. The meeting took place from 10:00 a.m. to 2:30 p.m. at the Tetra Tech EM Inc. (TtEMI) offices in San Francisco, California.

The following people attended the meeting:

Gilbert Rivera	Naval Facilities Engineering Command, Engineering Field Activity West (EFA WEST)
Tony Tactay	EFA WEST
Rudy Pontemayor	Naval Weapons Station SBD Concord
Amado Andal	Naval Weapons Station SBD Concord
Phillip Ramsey	U.S. Environmental Protection Agency (EPA)
Sonce de Vries	EPA and U.S. Fish and Wildlife Service (USFWS)
Laurent Meillier	Regional Water Quality Control Board (RWQCB)
Ray Bienert	TtEMI
Mary Gleason	TtEMI
Rik Lantz	TtEMI (via telephone)
Lynne Haroun	TtEMI
Richard Vernimen	TtEMI
Hilary Waites	Tech Law, Inc.

I. Introductions

Meeting participants introduced themselves. The meeting agenda is included as Attachment 1. The meeting handout is included as Attachment 2.

II. Navy's Response to Comments

Mary Gleason (TtEMI) initiated a discussion of general comments received via electronic mail (e-mail) from Laurent Meillier (RWQCB) on the Navy's response-to-comments (RTC) on the Navy's draft Five Year Periodic Review Assessment report (dated June 21, 2001).
Ms. Gleason paraphrased one of Mr. Meillier's comments regarding identification of an appropriate salt marsh reference site for the Litigation Area. Ms. Sonce de Vries (USFWS/EPA) stated that Jim Haas (USFWS) believes a Mare Island salt marsh area may qualify as an appropriate reference site. Ms. de Vries noted, however, that opinions on reference sites vary within the USFWS.

Ms. Gleason stated that reference area selection is largely dependent on the type of risk assessment or management questions to be answered. Ms. de Vries agreed and stated that establishing what questions are would help the agencies decide on the need for a reference site, and which reference sites might be appropriate.

Phillip Ramsey (EPA) inquired about previous attempts to establish a marsh reference site for the Litigation Area. Ms. Gleason described problems with some of the sites initially selected as reference sites, including vegetation differences and the detection of chemicals in reference site soil samples. Ms. Gleason stated that it was especially difficult to find an uncontaminated site on the southern shore of Suisun Bay that was similar in vegetation and hydrology to the Litigation Area.

Mr. Meillier remarked that when the land bordering Suisun Bay is viewed from the slopes of Mt. Diablo, there appear to be several wetland areas similar to the Litigation Area that could serve as reference sites. Ms. Gleason acknowledged that there are other wetland areas close to the Litigation Area; however, most of them, such as the Hastings Slough wetlands, are subject to contamination from nearby oil refinery operations. Further, Ms. Gleason stated that the risk management questions to be answered at the Litigation Area by not be addressed by a single reference area.

The group agreed that prior to considering reference sites, the risk management questions to be answered should first be established. If a reference area would help answer a question, the question will be used as the primary guide in selecting the reference site or sites for the Litigation Area.

Ms. Gleason initiated discussion on another of Mr. Meillier's general comments regarding the lack of edaphic and climatic data in the five-year review. Ms. Gleason stated that available physical and chemical data for Litigation Area soils is contained in Appendix F of the Year 5 monitoring report. This data includes soil grain size, total organic carbon content, color, pH, and conductivity. Mr. Meillier said he would review the Appendix F data.

Ms. Gleason asked Mr. Meillier what climatic data for the Litigation Area he is interested in, and why. Mr. Meillier replied that he would be interested specifically in historic rainfall data for the site because it may have influenced sediment transfer processes and the saturation condition of the soil during sampling events. Ms. Gleason acknowledged that the five-year review report lacks specific rainfall data; however, the report does state whether samples were collected in the wet or dry seasons. Ms. Gleason added that a surface water investigation was conducted in which wet season and dry season water samples were compared. Water turbidity data was collected as part of that investigation to help determine the nature of sediment transfer at the Litigation Area. Mr. Meillier noted that several Internet web sites list climatic data for specific locations. Ms. Gleason agreed that some additional local climatic data could be added to the environmental setting section of the draft final five-year review report.

Hilary Waites (Tech Law, Inc.) asked if the five-year review report would be reissued. Ms. Gleason said that the Navy plans to reissue the report. Mr. Ramsey raised the possibility of revising the five-year review report with a package of revised pages to be inserted in the existing document, rather than reissuing the whole report. Ms. Gleason reviewed some of the revisions planned for the report, including more specific recommendations for next steps, a new figure showing proposed sampling locations, a revised environmental setting section, the addition of responses to comments and meeting minutes to the appendices, a new Navy document control number, and miscellaneous minor corrections. Ms. de Vries stated that based on the report changes Ms. Gleason had described; a formal reissue may not be necessary. Ms. Gleason agreed, but noted that in the context of the Navy's document control system, formally reissuing a revised report with a new document control number would be the preferred option. Mr. Gilbert Rivera (EFA WEST) concluded that the Navy would reconsider the option of producing a "page substitution" revision versus reissuing a new document.

Ms. Gleason read a comment by Mr. Meillier regarding the Navy's plan to not study sediment flux at the Litigation Area. Ms. Gleason stated that the proposed supplemental feasibility study would address sediment migration concerns at the Litigation Area.

Ms. Gleason read a comment by Mr. Meiller regarding quantification of historic hydrocarbon contamination at remedial action subsite (RASS) 3. In response, Ms. Gleason stated that the results of a soil and groundwater investigation in the area concluded that a complete exposure pathway does not exist for the total petroleum hydrocarbon (TPH) contamination since it was detected in soils at least 15 feet below ground surface and not in shallower soil. Further, according to the RASS 3 investigation, TPH was not detected in groundwater at the site. Mr. Meillier asked about the range of TPH concentrations detected in RASS 3 soil samples. Ms. Gleason responded that the she did not have that TPH data at hand, but that the information is available in a RASS 3 investigation report, known as the "Hydrocarbon Report" for RASS 3.

Mr. Meillier noted that the TPH issue for RASS 3 might not be a Comprehensive Environmental Response Compensation and Liability Act (CERCLA) issue. Mr. Ramsey stated that TPH in RASS 3 might fall under CERCLA if the source of TPH contamination has not been determined. Ms. Gleason stated that the RASS 3 TPH soil contamination likely came from the abandoned Getty Oil facility. Mr. Ramsey stated that the TPH contamination might be the result of waste discharged from the Chemical & Pigment Company site adjacent to RASS 3. Mr. Ramsey further stated that EPA is not overly concerned with TPH contamination at RASS 3 and would defer to Mr. Meillier and RWQCB for regulatory review of this issue. Rik Lantz (TtEMI) stated that TPH was detected in RASS 3 groundwater samples at concentrations ranging from 70 to 200 parts per billion (ppb). Mr. Lantz added that the chromatograms for samples analyzed for TPH did not show patterns typical of fuels and volatile organic compounds (VOC) were not detected. Ms. Gleason concluded the RASS 3 TPH discussion by stating that the Draft Final Five-Year Periodic Review Assessment report would include additional discussion of TPH concentrations in RASS 3.

Mr. Ramsey noted that references to EPA comments in the Navy's RTC document should reference the date that the EPA comments were prepared, not the date the comments were received by the Navy. Ms. Gleason agreed and stated that the Navy's RTC document will be included as an appendix in the draft final five-year review report.

III. Human Health Risk

Ms. Gleason said that Ms. Lynne Haroun (TtEMI) was attending the meeting to address any human health risk assessment (HHRA) issues or questions. Ms. Gleason stated that John Christopher of the California Environmental Protection Agency, Department of Toxic Substances Control had no significant comments on the HHRA portion of the draft five-year review report.

Mr. Ramsey initiated a discussion of unauthorized access at RASS 4, particularly by individuals trespassing in the area with off-highway vehicles. Ms. Gleason acknowledged that trespassing at RASS 4 is a continuing problem and that there are plans for more secure perimeter fencing around RASS 4.

Rudy Pontemayor (Naval Weapons Station SBD Concord) described proposed plans for installing additional perimeter fencing at RASS 4. Mr. Pontemayor also stated that a chain securing a gate, that blocks vehicle access to Navy property south of Nichols Road, had been cut on approximately March 18, 2002. Mr. Pontemayor acknowledged that off-roaders trespassing on potentially contaminated Navy property posed a significant security and liability issue. Mr. Pontemayor also noted that additional security patrols had been proposed for the area, but that the present trend at the installation is a reduction in security patrol personnel.

Mr. Ramsey suggested that perhaps security should be part of the institutional controls proposed under the risk management for RASS 4. Mr. Ramsey stated further that currently it is assumed in the HHRA that no public access exists to RASS 4 given that it is posted and restricted Navy property. The continued trespassing on the site, however, has shown that illegal public access to the site needs to be considered in risk management decisions. Mr. Rivera stated that the Navy could implement stronger security measures at RASS 4 such as additional fencing, signage and patrols. Ms. Gleason stated that additional discussion of RASS 4 security measures could be added to the draft final five-year review report.

Tony Tactay (EFA WEST) asked about plans to investigate soil at RASS 4 that appears to be mixed with an ash-like material. The group discussed possible sources and nature of the material. Mr. Rivera stated that the Navy was willing to sample the semi-lithified material at RASS 4.

Ms. Gleason asked if the group had any other HHRA issues or concerns. Lynne Haroun (TtEMI) stated that most regulatory agency comments concurred with those of EPA. Ms. Haroun further stated that none of the agency comments merited making any changes to the HHRA analysis because it supports the risk management decisions that need to be made. Ms. Haroun acknowledged that additional HHRA information might be needed to address RASS 4 trespass site user scenarios.

IV. Navy's Proposed Plan for Additional Sampling

Ms. Gleason referred the group to the section of the meeting handout (Attachment 2) describing the Navy's proposed plan for additional sampling at Litigation Area sites.

A. Distressed Vegetation Area

Ms. Gleason, referring to the distressed vegetation in RASS 1 and Figure 1.0 of the handout, explained that soil and groundwater sample locations were being proposed for both inside and outside of the distressed vegetation area, in order to determine potential contaminant concentration gradients.

Mr. Lantz stated that the approximately 3-foot-deep pits that would be dug at grab groundwater sampling locations might have to stabilize overnight following their excavation to allow an adequate volume of groundwater to enter the pit for sample collection. Ms. Waites inquired whether the proposed groundwater investigation would merit installation of temporary wells, and whether groundwater flow direction and water table depth at the distressed vegetation area were known. Mr. Lantz stated that, based on data from monitoring wells at the General Chemical site, groundwater flows in a westerly direction toward the Litigation Area. Mr. Lantz said the water table is at approximately 1 to 3 feet below ground surface (bgs) and that collection of grab groundwater samples does not merit the installation of temporary monitoring wells. He added that temporary monitoring wells would be difficult to seal from tidal area flooding and may be less likely to produce the needed groundwater sample volume than the proposed pits.

Ms. Waites asked why the grab groundwater samples would be filtered. Mr. Lantz explained that since the groundwater samples will be grab samples from pits instead of from developed monitoring wells, it is necessary to filter the water samples to remove particulates. Ms. Gleason stated that the feasibility of collecting both filtered and unfiltered groundwater grab samples would be evaluated when the field sampling plan for the distressed vegetation area is developed.

Mr. Meiller asked Mr. Lantz about a deep (greater than 20 feet bgs) sandy aquifer that was mentioned in a groundwater assessment report for Site 1 (the Tidal Area Landfill, approximately one mile west of the Litigation Area) at Naval Weapons Station SBD Concord. Mr. Lantz said that based on his knowledge of the well boring logs for the Litigation Area, there is no sandy aquifer between 0 and 20 feet bgs; however, he speculated that there may be a sandy unit in the vicinity of the railroad tracks. Mr. Lantz said that if a sandy aquifer is present at the Litigation Area, it exists much deeper than 20 feet bgs and has not been sampled.

Mr. Ramsey noted that there are sandy subsurface features in other areas of Contra Costa County. Mr. Meillier stated that he is concerned about the possibility of a sand layer as a pathway for contamination. Mr. Lantz stated that even if a sand layer exists below 20 feet bgs, the vertical transport of contaminants from the surface through greater than 20 feet of mud would probably be very slow based on what is known about horizontal transport at the site. Mr. Meillier acknowledged this, but he suggested that some heterogeneity in a subsurface sand layer might allow vertical transport of contaminants in some areas.

Ms. Waites asked about groundwater data from well R01AG003, the well closest to the distressed vegetation area. Ms. Gleason stated that Litigation Area groundwater wells would be sampled under the proposed plans for additional sampling. Ms. Waites asked if sampling similar to the sampling done for the RASS 1 tidal influence study is proposed. Mr. Lantz said that data collected during the tidal influence study did not reveal any tidal influence in the RASS 1 wells. He added that the pressure transducers placed in wells for the tidal influence study detected no movement in the water column over several tidal cycles.

Mr. Meillier stated that, given the low hydraulic conductivity of RASS 1 soils, the use of pressure transducers in the tidal influence study was probably an inappropriate method. Mr. Meillier stated three concerns about the groundwater status of RASS 1: (1) groundwater at RASS 1 may be still contaminated, (2) contamination may be migrating through a stratigraphic layer at the site that has not been characterized, and (3) there are no groundwater monitoring wells at the margin of Suisun Bay.

Mr. Lantz noted that metals concentrations in groundwater decreased significantly after remediation was completed. He said that installing ground-water monitoring wells on the margin of Suisun Bay is technically infeasible. Ms. Gleason noted that the Navy's proposed plan for sampling at the distressed vegetation area includes collecting grab groundwater samples near the shoreline of Suisun Bay. Ms. Gleason also stated that no soil contamination has been detected along the Suisun Bay margins to merit further sampling. Mr. Meillier acknowledged this, but stated that the grab groundwater samples would not provide the data of the same quality as groundwater samples from a monitoring well. In regards to understanding stratigraphy, Ms. Gleason added that a file review of groundwater well information for the adjacent Honeywell site might provide more information on the deep stratigraphy in the area.

B. Litigation Area Groundwater Wells

Mr. Lantz initiated a discussion of Litigation Area groundwater wells. Mr. Lantz said he disagreed with Mr. Meillier's characterization of the RASS 1 stratigraphy as complex. Mr. Lantz noted that the well logs for twelve RASS 1 wells show stratigraphy consisting of silty clay to 20 feet bgs. Mr. Meillier stated that the "R Area" landfill (Site 1) shows more heterogeneity in its stratigraphy, as do upslope areas in the Litigation Area, so it is not improbable that some heterogeneity exists in the RASS 1 area. Mr. Meiller added that no well log data below 20 feet bgs is available to confirm that stratigraphy at RASS 1 is the same below that depth. The group agreed to look at the stratigraphy of deeper wells on neighboring properties during the file review.

Mr. Meillier inquired why the Navy proposes only one round of groundwater sampling at the Litigation Area. Mr. Meillier also stated that groundwater tracer studies would provide additional fate-and-transport data.

Mr. Lantz stated that based on a review of 19 quarters of groundwater data at the Litigation Area, no difference was observed between wet season and dry season data sets, so four quarters of groundwater sampling is not necessary. Ms. Gleason said that the regulatory agencies had agreed to remove the groundwater monitoring requirement at the Litigation Area after the Year 2 (1996) monitoring report. She said the proposed round of groundwater sampling would serve as a check-up of Litigation Area groundwater since that time.

Mr. Ramsey asked whether the lack of a seasonal difference in groundwater constituent concentrations was documented. Mr. Lantz stated that conclusions from his review of Litigation Area groundwater data could be presented more formally but he maintained that the conclusion that there is no seasonal difference in the data is relatively straightforward.

Mr. Ramsey proposed that the Navy's conclusions regarding the lack of a seasonal difference in groundwater concentrations be considered valid, but that if the proposed round of groundwater sampling detected any significant concentrations, some follow-up investigation should be conducted. Mr. Lantz said that he anticipates that concentrations of most groundwater constituents at the Litigation Area have decreased since 1996. Mr. Ramsey reiterated that if the groundwater investigation reveals anything unusual, additional groundwater characterization might be necessary. Mr. Rivera stated that the Navy's original proposal is to resample all Litigation Area wells and to follow up on the findings of the proposed sampling. Mr. Meillier said he would like to have input on the decision as to which quarter the Litigation Area groundwater will be sampled.

C. Chemical Pigment Company Border

The group discussed the Navy's proposed plan for Chemical Pigment Company (CPC), as described in the meeting handout (Attachment 2).

Ms. Gleason stated that a groundwater tracer study might work best in the wells near the CPC site. Ms. Gleason inquired about the time frame to be considered if a tracer study reveals that groundwater constituents are migrating very slowly. Mr. Meillier agreed that constituent transport is probably very slow, but he said there might be heterogeneity in the subsurface that causes greater hydraulic conductivity than initially assumed. He said previous studies at other sites showed that the tracers appeared in down gradient wells within a reasonable time frame.

Mr. Lantz agreed that the CPC site may be suited for a groundwater tracer study, but he said that more information is needed on the nature of the groundwater flow and potentiometric surface at the site. Mr. Lantz proposed the following approach for gathering additional groundwater data at the CPC site: Conduct a review of all available CPC wells to establish a current data set of groundwater levels, constituent concentrations, and lithology; based on the findings of the investigations, consider whether installation of additional monitoring wells is needed. Ms. Gleason stated that there might be property access issues involved in installing new groundwater monitoring wells at the CPC site. The group generally agreed with Mr. Lantz's approach to additional investigation at the CPC site.

D. PCB Sampling in RASS 3

Ray Bienert (TtEMI) referred to the handout and Figure 2.0 in explaining the existing and proposed polychlorinated biphenyl (PCB) sampling locations in RASS 3.

Mr. Ramsey inquired about the detection limits for the proposed Aroclor analysis using standard Contract Laboratory Program (CLP) methods. Ms. Waites stated that the detection limits for the proposed Aroclor analysis should be similar to the detection limits achieved for previous RASS 3 PCB analyses. Ms. Gleason stated that the ecological risk assessment for the draft five-year review report did not find risk to receptors from PCBs at concentrations below 1.5 milligrams per kilogram (mg/kg). As a result, she anticipates that only soil samples in which Aroclor concentrations exceed 1.5 mg/kg will require additional evaluation. Ms. Gleason said she believed the Aroclor analysis detection limit was approximately 1.0 mg/kg.

Ms. Waites stated that individual PCB congener analysis is substantially more expensive than Aroclor analysis, and inquired whether the proposed PCB congener analyses are justified. Mr. Bienert explained that PCB congener analysis is being conducted to further characterize those areas where PCB Aroclors were previously detected.

Ms. de Vries inquired as to whether the railroad companies are being viewed as the most likely source of PCBs in RASS 3 soils, given that the proposed PCB sampling focuses on the RASS 3 railroad right-of-way, or whether there was a possibility that PCBs were deposited from an upstream source near Nichols Creek. Ms. Gleason stated that railroad operations are considered the most likely source of PCBs in RASS 3, and that Aroclors were not detected in three soil samples collected from upstream sections of Nichols Creek during previous investigations. Mr. Bienert stated that the plan would be revised to include sample locations for Aroclor PCB analysis along the historic drainage pathway of Nichols Creek. The group agreed that Aroclor analysis was sufficient provided that the detection limit was less than 1.5 mg/kg.

V. Proposed Scope of Supplemental Feasibility Studies

Ms. Gleason referred to the handout in describing the proposed scope of supplemental feasibility studies at the Litigation Area. Ms. Gleason stated further that the proposals described in the handout and discussion of the proposals at this meeting would provide a basis for Mr. Rivera to prepare the Navy's scope of work for the project. Ms. Gleason also stated that more specific information would be provided when the feasibility studies are fully scoped.

A. RASS 1 – Unit 7 Ditches

Ms. Gleason reviewed the problem, the area under consideration, the overall remedial goal, remedial alternatives, and special considerations described in the handout for a supplemental feasibility study in the RASS 1 – Unit 7 ditches (Attachment 2).

Ms. Waites stated that the natural filling (passive remediation) alternative is likely to require a significant amount of monitoring time to determine if the overall remedial goal of reducing or eliminating mobilization of contaminated sediments from the bottoms of the mosquito ditches is being met. Mr. Lantz stated that the assisted passive filling alternative is attractive based on the southern ditch in Unit 7, which has filled in significantly since its connection to Lost Slough was obstructed and tidal flows to the ditch were consequently restricted.

Mr. Ramsey stated that assisted passive filling has been observed to occur, but that the rate of ditch filling has not been quantified. Mr. Lantz stated that the depth of the southern ditch in Unit 7 has been measured as part of the Litigation Area monitoring efforts, and profile diagrams of the ditch's depth have been produced for the various monitoring years. Ms. Gleason showed the ditch profile diagram of the Unit 7 southern ditch to Mr. Ramsey. Mr. Ramsey questioned whether the southern ditch filling represents strong enough evidence for a valid feasibility study alternative. He further stated that an estimate should be made of the number of years required for a ditch to fill in under this alternative. Ms. Gleason stated that issues related to the selection of remedial alternatives for the Unit 7 ditches would benefit from discussion with the Contra Costa County Mosquito and Vector Abatement Control District personnel, who have conducted pilot studies on this issue in the area.

Ms. Waites presented the idea of "hot spot" removal of ditch contamination. For example, depending on the contamination found in a given ditch or section of a ditch, active removal, active filling, or no action may be proposed. Mr. Ramsey stated that he thinks a combination of remedial alternatives may be the best solution for addressing ditch contamination.

Mr. Meillier inquired about what the marsh drainage was like prior to construction of the drainage ditches. Ms. Gleason speculated that there was sheet flow over the marsh surface during tidal cycles.

Mr. Meillier stated that fill material used in the proposed "active filling" remedy should match the characteristics of the native ditch sediments. That is, the fill material should be similar in characteristics such as grain size, permeability, and oxidation-reduction potential. Mr. Meillier stated that similar fill material would help maintain a homogeneous marsh surface and limit the creation of new contamination migration pathways. Mr. Lantz and Mr. Ramsey stated that fill material with a larger grain size than the native material may be required to hold native sediment in place, and that this fill material would not necessarily create a new contamination migration pathway. Mr. Bienert stated that fill material issues could be researched and presented in the feasibility study.

Mr. Lantz pointed out that, generally, the distal ends of the ditches are the most contaminated. Ms. Waites stated that if the distal ends of ditches are localized "hot spots," active removal of sediments at these locations appeared to be a reasonable alternative. Ms. Gleason said that digging in the ditches could mix and aerate exposed sediments, creating new sediment "hot spots" over time as the sediments are transported to different parts of the ditch. Mr. Ramsey reiterated that applying combinations and subsets of the proposed alternatives may be the preferred approach, and the group agreed that should be included in the evaluation.

Ms. Gleason inquired about USFWS requirements for attaining concurrence on the feasibility study alternatives. Ms. de Vries suggested that an informal consultation be arranged with USFWS endangered species staff following preparation of the draft supplemental feasibility study. Ms. de Vries added that the amount of input from USFWS staff would probably depend on the amount of habitat disturbance proposed for the ditch and surrounding marsh habitats. Ms. de Vries acknowledged the special considerations described in the meeting handout for the proposed remedial actions and also stated that the Navy could request informal feedback on the draft supplemental feasibility study as it is being prepared.

B. RASS 1 – Unit 11 Slough

Ms. Gleason reviewed the problem, the area under consideration, the remedial goal, possible remedial alternatives, and special considerations described in the handout for a supplemental feasibility study in the RASS 1 – Unit 11 slough (Attachment 2).

Ms. Waites asked for a clarification of the special consideration described in the handout regarding flow velocities in Lost Slough and how they might affect the proposed remedial alternatives. Mr. Lantz stated that water flows faster in the Unit 11 slough compared to the Unit 7 ditches, so a coarser substrate such as gravel may be needed to maintain a barrier layer in place against the slough current.

Ms. Gleason stated that the impacts of implementing the active remedial alternatives (sediment removal and barrier placement) might be greater than the ecological risk posed by a no-action alternative. She pointed out that the hazardous constituents in the contaminated sediments generally are not bioavailable. Mr. Ramsey said that it is important to define the effectiveness of the passive remediation alternative and whether the impacts from the active alternatives will be short-term or long-term impacts. Further, Mr. Ramsey was concerned that the passive alternative would lead to contaminated sediment moving back and forth in the slough without being covered by clean sediment. Mr. Lantz stated that sediment accretion is occurring in the slough, but that the accretion does not occur as uniformly as in some ditch locations. Mr. Ramsey said that he recognized that sediment accretion rates in the slough are dependent on the shape of a given section of the slough, as well as other factors.

Ms. Waites inquired about the feasibility of sediment "hot spot" removal, especially as a means to reduce the amount of contaminated sediment at bends in the slough. Ms. Gleason stated that, similar to consideration of remedial alternatives for the Unit 7 ditches, combinations and subsets of alternatives should be considered for the Unit 11 slough.

Mr. Ramsey addressed the last bullet item under Unit 11 "Special Consideration" on the handout that states: "Upgradient sources should be addressed before remediating Lost Slough to avoid recontamination of slough bottom sediments." Mr. Ramsey said that although he appreciates the need to minimize off-site contamination, EPA does not want to wait for remediation of upgradient sources before implementing remedial alternatives at the Litigation Area. Mr. Rivera said he was reluctant to modify the language of the statement because it addresses a policy requirement from the Navy's point of view. Mr. Ramsey reiterated that EPA is concerned about off site contamination, but does not agree with the statement's implication that remediation should be postponed. Mr. Ramsey said he does not want it to appear that the addressing concerns at the Litigation Area was delayed when time was available to spur off-site potentially responsible parties into action. Mr. Rivera stated that the five-year review report has brought off site sources to the attention of the Navy, and the Navy is now taking action to address those concerns.

Ms. Gleason stated that bends in the Unit 11 slough (where sediment is deposited) are viewed as sinks for off-site contamination, and since these areas are proposed for remediation under the supplemental feasibility study, off-site contamination is an important issue. Ms. Gleason also reiterated that off-site sources of contamination would be further characterized using information gathered from proposed file reviews for these sites.

Mr. Ramsey stated that he recognizes that gathering information on adjacent sites such as CPC is a priority for the Navy and that there do exist Consent Decrees with the neighboring facilities. Mr. Rivera stated that the Navy is essentially moving forward and addressing its responsibilities on its property in parallel with its efforts to gather information on potential off-site sources of contamination.

C. RASS 3 – Erosion Areas

Ms. Gleason reviewed the problem, the area under consideration, the remedial goal, possible remedial alternatives, and special considerations described in the handout for a supplemental feasibility study in the RASS 3 – Erosional Areas (Attachment 2). Ms. Gleason stated that the proposed remedial alternatives emphasize stabilization of the eroded areas rather than remediation of soils.

Ms. Waites asked if any contaminated areas are being eroded. Ms. Gleason stated that there are no soil samples from the eroded areas; however, the cleanup level for zinc at RASS 3 was 5,000 mg/kg, and soil samples near the eroded areas contain concentrations of zinc close to this cleanup value.

Ms. Waites asked for some clarification on the proposed alternative for recontouring the creek bed. Mr. Lantz explained that recontouring the creek bed would change the rate at which creek bed material would reach the RASS 3 pond.

Mr. Ramsey stated that different segments of the creek channel might need to be viewed separately in terms of the need for stabilization. That is, the more "braided" downstream portion of the stream channel may need to be considered separately from the upstream areas of erosion. Mr. Lantz said the proposed remedial alternatives focus on the north-south portion of Nichols Creek and not the "braided' creek bed downstream. Mr. Ramsey also introduced the possibility of an engineered alternative for the creek bed, such as a sediment trap. Ms. Gleason said an engineered alternative would be added to the list of remedial alternatives under evaluation.

D. Other Issues Raised During the Meeting

Ms. Waites inquired about future monitoring requirements at the Litigation Area in light of comments received on the five-year review report. Ms. Gleason stated that limited and focused monitoring is proposed, as described in the Navy's responses to comments on the five-year review report. Ms. Gleason stated further that future monitoring might focus on the implementation and success of any additional remedial alternatives.

Mr. Pontemayor inquired about the time frame for the supplemental feasibility study. Ms. Gleason stated that the time frame is largely dependent on Navy budgetary issues. Mr. Ramsey noted that a supplementary feasibility study schedule is not included in the site management plan. Mr. Pontemayor stated that this post-five-year work would become the responsibility of the local (Naval Weapons Station SBD Concord) base authorities.

Mr. Rivera stated that Department of Defense funding would run through finalizing the five-year review, and further stated that the local installation would be responsible for funding from that point on. However, Mr. Rivera stated that there are a variety of funding options for the local installation, and these could be discussed in the future.

Mr. Ramsey inquired about the availability of funding for preparing a scope of work for the supplemental feasibility study. Mr. Pontemayor stated that the supplemental feasibility study activities need to be planned in phases, and funding would be requested in a similar phased manner.

Mr. Ramsey stated that the Federal Facility Agreement and related enforceable schedules should aid the Navy in seeking funding priority. Mr. Rivera acknowledged that these schedules play a role in the Navy's formal funding requests. Mr. Ramsey stated that the regulatory agencies would need to work together to be sure a schedule is in place. Mr. Rivera stated that the site management plan takes schedule and funding availability into account. Mr. Ramsey asked if there was presently a rough idea of a supplemental feasibility study schedule. Mr. Rivera stated that the feasibility scoping process can begin, but that the entire scoping documentation package needs to be completed before a schedule can be established.

VI. Action Items and Schedule for Submittal of Draft Final Five-Year Periodic Review Assessment Report

No action items were identified.

The group concluded the meeting at 2:30 pm.

The draft final Five-Year Periodic Review Assessment report is due to the agencies on April 30, 2002. Another risk management meeting was not scheduled.

ATTACHMENT 1

AGENDA
RISK MANAGEMENT MEETING
FIVE-YEAR PERIODIC REVIEW ASSESSMENT
LITIGATION AREA SITES, NWSSB DETACHMENT CONCORD
Wednesday, March 27, 2002
10:00 AM - 2:00 PM
Tetra Tech EMI, Large Conference Room
135 Main Street, Suite 1800
San Francisco

Meeting Objectives: The objectives of the meeting are to discuss and get agency input on 1) the Navy's response to comments document submitted March 1, 2) any human health risk issues or concerns, 3) the Navy's proposed plan for additional sampling efforts, and 4) the Navy's proposed scope for the supplemental feasibility studies.

I. Introductions (10 minutes)

II. Navy's Response to Comments (15 minutes)

III. Human health risk (10 minutes)

IV. Navy's proposed plan for additional sampling

a. Distressed vegetation area (15 minutes)
b. Chemical Pigment company border (20 minutes)
c. Litigation Area Groundwater wells (15 minutes)
d. PCB sampling in RASS 3 (10 minutes)

V. Scope of supplemental feasibility studies

a. RASS 1- Unit 7 ditches (30 minutes)
b. RASS 1 - Unit 11 slough (30 minutes)
c. RASS 3 - erosional areas (20 minutes)

VI. Action items and schedule for submittal of Draft Final Five –Year Periodic Review Assessment Report (10 minutes*)*

ATTACHMENT 2

HANDOUT
Risk Management Meeting
Litigation Area
Naval Weapons Station Seal Beach Detachment (NWSSBD) Concord
March 27, 2002

Meeting Objective: The objectives of the meeting are to discuss and get agency input on 1) the Navy's response to comments document submitted March 1, 2002, 2) any human health risk issues or concerns, 3) the Navy's proposed plan for additional sampling efforts, and 4) the Navy's proposed scope for the supplemental feasibility studies.

This handout presents the Navy's proposed plan for additional sampling and scope for the supplemental feasibility studies. These issues will be discussed with the agencies at the meeting and incorporated in summary form in the Draft Final Five-year Periodic Review Assessment report. A Field Sampling Plan/Quality Assurance Project Plan would be written prior to conducting any additional sampling.

PROPOSED PLAN FOR ADDITIONAL SAMPLING:

a. RASS 1 Distressed Vegetation Area:

***Problem*:** An area of distressed vegetation was observed in the remediated area of RASS 1 along the berm separating the General Chemical facility and the Honeywell alum waste ponds from the Navy's property. A file review documented high groundwater and soil concentrations of metals, low pH, and a westward flow of groundwater toward the Litigation Area. A focused investigation is required to determine if the area of distressed vegetation observed in RASS 1 is the result of chemical migration from the General Chemical facility onto Navy property.

Area Under Consideration: The area of distressed vegetation observed in the remediated portion (Unit 8) of RASS 1 along the berm separating Navy property from the General Chemical facility and Honeywell, Inc; the investigation will extend beyond the area of distressed vegetation to allow comparison with areas with normal vegetation (Figure 1).

***Data Needs*:**

- additional information on historic and ongoing activities and investigations at the General Chemical facility and Honeywell, Inc
- surface and subsurface soil samples inside and outside the area of distressed vegetation
- groundwater grab samples (collocated with a subset of soil samples)
- geologic cross-sections extending across the site boundary onto General Chemical property based on existing well logs

Proposed Tasks and Analyses:

1) Conduct additional review of files for the General Chemical facility and Honeywell, Inc. sites to determine chemicals of concern, available data, and status of ongoing investigations.

2) Collect surface (0 to 0.5 feet below ground surface [bgs]) and subsurface (1.0 to 1.5 feet bgs) soil samples at 15 locations (total of 30 samples) in an array parallel and perpendicular to the berm, as shown in Figure 1. Samples will be homogenized and analyzed for total metals, pH, and total organic carbon.
3) Collect groundwater grab samples at 9 locations collocated with the soil samples, as shown in Figure 1. Groundwater grab samples will be filtered and analyzed for total metals and pH.
4) Prepare geological cross-sections based on existing data from documents obtained during file review.

Special Considerations:

- If additional file reviews for the General Chemical facility and Honeywell, Inc. indicate the potential for migration of contaminants other than metals, additional chemical analyses may be conducted as part of this focused investigation.
- Because of the slow expected recharge rate for the groundwater grab samples, it may be necessary to allow the pits to fill overnight and return the following day to collect the samples.

b. Chemical and Pigment Company (CPC) Border:

***Problem*:** Historical data shows high concentrations of zinc in groundwater samples collected from wells in the center and at the northwest corner of CPC in 1998; this contamination may be flowing toward Navy property or day-lighting into Nichols Creek. Groundwater flows to the north or west in this area based on data from wells located on NWSSBD Concord property; groundwater flows to the west in the perched zone and flows to the northeast in the deeper sand body based on reports submitted for CPC. The extent of groundwater/surface water interaction in Nichols Creek near the CPC border is unknown.

Area under consideration: The Navy's property that borders the northwestern corner of Chemical and Pigment property along Nichols Creek and adjacent areas in RASS 3.

***Data needs*:**

- Current groundwater potentiometric surface extending across property boundaries;
- Better lithologic data in vicinity of property boundary;
- Elevations of groundwater and surface water in Nichols Creek.

***Proposed tasks and analyses*:**

1) Conduct additional file review of CPC site. Obtain and review entire Hydrogeologic Assessment Report prepared by Environmental Solutions in 1987, as well as more recent reports. Obtain most recent groundwater analytical data and potentiometric elevations from CPC wells (if available).
2) Install one or two new wells on Navy property near border of CPC. Review property records and determine location to install new downgradient monitoring well on Navy property, as close to boundary with CPC as possible. Perform detailed lithologic logging of new wells to assess presence of 'perched zone' or other preferential flow pathways. Sample wells during water level measurement events when flow relationships between groundwater and surface water elevations are known.

3) Perform synoptic water level measurement in the complete set of wells (Navy wells and CPC wells), to define flow direction in 'perched zone' and shallow aquifer.
4) Survey elevation of Nichols Creek and establish staff gauge to allow periodic measurement of surface water elevation in Nichols Creek. Measure groundwater and surface water levels during the extreme conditions (late winter and late summer) to evaluate the range of conditions experienced throughout the year.
5) Evaluate suitability of a tracer test using SF_6 or similar tracer to directly assess connection between groundwater and Nichols Creek.

***Special Considerations*:**

- Requires access to CPC property and wells and coordination with DTSC.
- Property boundaries may complicate selection of locations for new wells.

c. Litigation Area Groundwater Wells:

Problem: Groundwater wells in the Litigation Area were most recently sampled in October of 1996; at that time 11 of the 22 monitoring wells were sampled. Wells need to be re-sampled to obtain more recent metals data. Historical data has consistently shown little or no contamination by organic contaminants.

***Area Under Consideration*:** Existing groundwater wells in RASSs 1, 2, 3, 4.

***Data Needs*:**

- Updated metals analytical data from all wells.
- Measure groundwater elevations in all Navy wells.
- Survey in the elevations of tops of wells (for long-term assessment of marsh subsidence or lifting due to tectonic action) and tie them into local and distant benchmarks.

***Proposed Tasks and Analyses*:**

1) Perform one round of groundwater sampling. Collect unfiltered groundwater samples for metals analysis from all wells using low-flow rate sampling techniques, or 'natural settling' techniques where wells are unable to support 0.1 liter per minute recharge rate.

Special Considerations:

- Wells should first be inspected to ensure compliance with California well standards.
- Sampling should be timed so that tidal flooding of marsh does not affect site access.
- Sampling can be done in any season; extensive historical data does not show evidence of seasonality.

d. RASS 3 PCB Data Gap:

***Problem*:** The baseline ecological risk assessment conducted as part of the five year review concluded that PCBs did not pose unacceptable risk to ecological receptors, but acknowledged that insufficient information existed for areas within RASS 3 along the railroad track property, to adequately characterize risk for this portion of the site. Total PCBs were detected at a concentration of 480 µg/kg at a single location in RASS 3 along the Southern Pacific Transportation Company railway tracks in 1996; confirmation sampling was performed at this location and total PCBs were measured at concentrations ranging from 70 to 1,500 µg/kg in three additional samples.

Area Under Consideration: The northern margin of RASS 3 adjacent to the Southern Pacific Transportation Company railway tracks; special attention will be given to locations where previous sampling has shown detected concentrations of PCB mixtures and spatial data gaps (Figure 2).

***Data Needs*:**

- Additional PCB analysis in soil samples in the northern portion of RASS 3 along the railroad track property and in the vicinity where the highest detected concentrations of PCB were found previously.

Proposed Tasks and Analyses:

1) Six surface soil samples (0-0.5 ft bgs) will be collected for analysis of PCB mixtures (seven Aroclors using standard CLP methods) along a corridor of approximately 1,800 feet adjacent to the railroad tracks in RASS 3. Samples will be collected at 6 locations, spaced approximately 300 feet apart (Figure 2); all locations will be on Navy property just beyond the 50-foot railway property right-of-way.

2) Ten additional surface (0-0.5 ft bgs) and subsurface (1-1.5 ft bgs) soil samples will be collected in a square array, centered on location R03SS214, where a total PCB concentration of 1,500 µg/kg was previously reported. Surface and subsurface samples will be collected from location R03SS214 and four additional locations in a square pattern with approximately 25 feet of separation between samples, as shown in the inset of Figure 2. Since this is an area where PCBs have previously been detected, this set of samples will be analyzed for PCB congeners using low-level methods.

***Special Considerations*:**

- If results of this analysis reveal that unacceptable levels of PCBs remain at selected locations along the railroad track property, then the Navy will request that the railroad company take measures to evaluate railroad property as the probable source(s) of PCB contamination. The Navy will work with the regulatory agencies to further evaluate the risk posed by residual concentrations of PCBs on Navy property, and to assess if remedial actions are warranted.

PROPOSED SCOPE FOR SUPPLEMENTAL FEASIBILITY STUDIES:

a. RASS 1 - Unit 7 Ditches:

***Problem*:** Ditches in Unit 7 consistently have high surface water and sediment concentrations of metals. Ditch profiles show that the proximal ends of the ditches are deeper than when originally installed, indicating that erosion is occurring in some parts of the ditches. Vertical profiles of contaminants show varied patterns indicating differential erosion and accretion of contaminated sediments in different parts of the ditches.

***Area under Consideration*:** The network of mosquito ditches in Unit 7 with a special focus on the ditches that connect to Lost Slough (including four major east-west ditches and a small connector between the northern- most ditch in Unit 7 and the eastern tributary to Lost Slough).

***Overall Remedial Goal*:** The overall remedial goal for Unit 7 is to reduce or eliminate mobilization of contaminated sediments from the bottoms of the mosquito ditches in Unit 7.

***Possible Remedial Alternatives To Evaluate*:**

- Active removal of contaminated sediment: Physical removal of the contaminated sediments would eliminate concerns about mobilization.
- Active filling: The ditches could be physically filled with clean fill or gravel to eliminate mobilization of ditch bottom sediments.
- Assisted passive filling: Evidence in other ditches shows that restricting flow of water during tidal cycles results in accumulation of sediments. Restricting flow in the ditches by installing flow barriers at the junction with Lost Slough and at other selected locations should be considered as a way to assist and speed up the natural filling process.
- Natural filling: Passive remediation (no action) and monitoring.
- No action alternative.

***Special Considerations*:**

- The affected ditches are not easily accessible and are flooded twice daily by tidal action. Remedial options must contend with access difficulties and reduced working periods due to tidal flooding.
- The adjacent marsh surface has high ecological value, and remedial actions must be designed to minimize damage to the wetland. The supplemental feasibility study should include an evaluation of habitat value of ditches and adjacent wetland that would be impacted by any action. Impacts of alternative actions on habitat value and special status species at the site should also be considered.
- Altering or removing the ditches will affect marsh hydrology. Hydrologic impacts on contaminant transfer, erosion, and the wetland ecology should be considered in the supplemental feasibility study.

b. RASS 1 Unit 11 Slough:

***Problem*:** Previous characterization has shown that the sediments of Lost Slough in Unit 11 are contaminated with metals at concentrations that pose ecological risk. Vertical profiles of metals indicated that some portions of the slough bottom have been scoured, raising the possibility that contaminants may be mobilized in this side arm of Lost Slough.

***Area Under Consideration*:** East-west trending arm of Lost Slough known as Unit 11.

***Remedial Goal*:** The overall remedial goals for Unit 11 are to reduce ecological risk and reduce or eliminate mobilization of contaminated sediments from the Unit 11 portion of Lost Slough.

***Possible Remedial Alternatives To Evaluate*:**

- Physical removal of the contaminated sediments: Removing the contaminated sediments would eliminate concerns about mobilization.
- Installing a physical barrier: Installing a physical barrier such as a gravel layer or geo-membrane at the bottom of the slough would isolate the contaminated sediments and prevent their mobilization.
- Monitoring and passive remediation.
- No action alternative.

***Special Considerations*:**

- Lost Slough is not easily accessible and the nearby marsh surface is flooded twice daily. Remedial options must contend with access difficulties and reduced working periods due to tidal flooding.
- The supplemental feasibility study should consider and evaluate the ecological value of the tidal slough and adjacent wetland; any remedial alternatives should be designed to minimize damage to the wetland and the tidal sloughs. The supplemental feasibility study should evaluate impacts of remedial alternatives on special status species at the site.
- Lost Slough experiences higher flow velocities than other parts of the ditch-slough system, and remedial options should consider ways to accommodate these flow velocities.
- Upgradient sources should be addressed before remediating Lost Slough to avoid recontamination of slough bottom sediments.

c. RASS 3 Erosional Areas:

***Problem*:** Nichols Creek is an ephemeral stream that borders the CPC facility, crosses through RASS 3, empties into a small wetland in RASS 3, and ultimately discharges into the slough in RASS 1. Contamination in the Nichols creek area was remediated; however, this action did not establish a new bed for Nichols Creek and a result, the creek has created its own course. Erosion of the creek bank has been observed and documented; erosion occurs in areas where nearby soils are contaminated, potentially mobilizing contaminants downstream toward the RASS 3 pond and into Lost Slough.

***Area Under Consideration*:** The Nichols Creek area in RASS 3 from the Chemical and Pigment Company northern boundary to RASS 3 pond.

***Remedial Goal*:** The goal of additional actions along Nichols Creek is to create a stable creek bed and prevent or decrease erosion of the creek bed and banks.

***Possible Remedial Alternatives To Evaluate*:**

- Vegetate unstable slopes to increase stability and decrease erosion of creek banks.
- Re-contour creek area to direct surface water flow to desired flow pathway.
- Line creek bed with gravel, cobbles, or rip-rap to create stable creek bed.
- Channelize Nichols Creek by creating a concrete lined creek bed.
- No action alternative.

***Special Considerations*:**

- The largest areas of active erosion occur on ATSF and Sacramento Northern railroad property near the culverts that run beneath the rail lines; concentrations of metals in this area are not known. The Navy would have to work with neighboring property owners to implement any actions.
- The supplemental feasibility study should evaluate various ways to minimize runoff to the RASS 3 and RASS 1 wetlands during and following any actions.
- Upgradient sources at CPC should be addressed before remediating the portion of Nichols Creek on Navy property to avoid recontamination of the creek bottom.

FIGURE 1.0

RASS 1 SAMPLING LOCATIONS IN AREA OF DISTRESSED VEGETATION

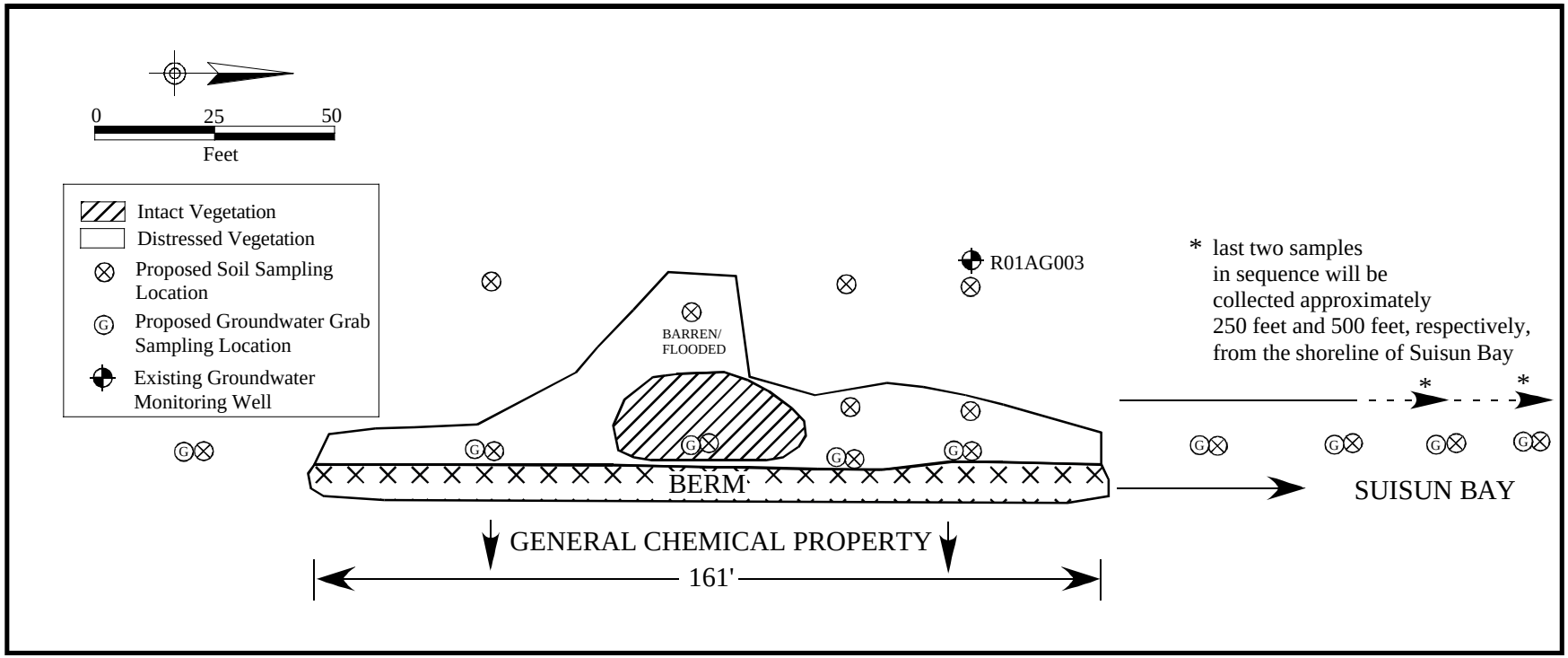
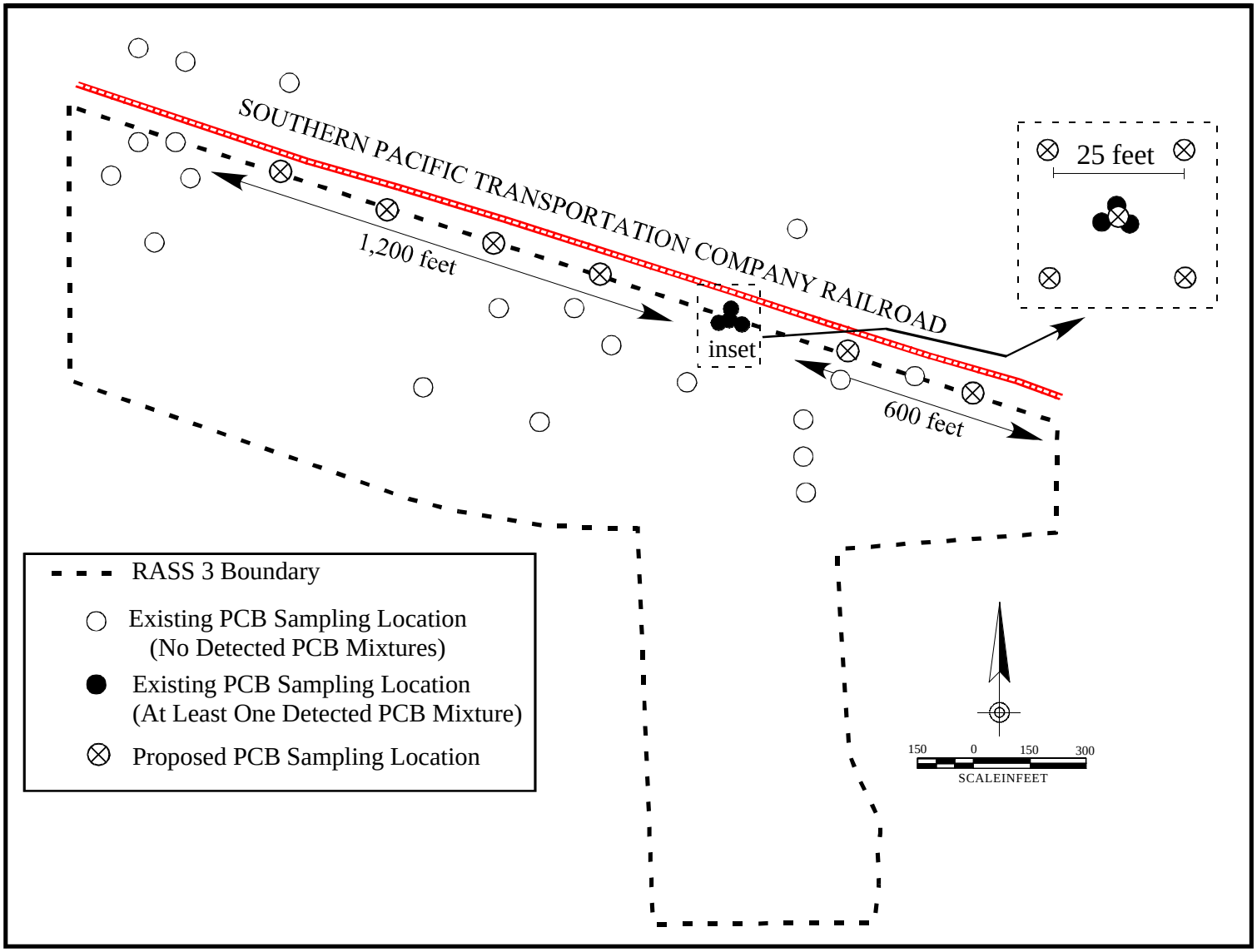


FIGURE 2.0

PCB SAMPLING LOCATIONS IN RASS 3



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Please wait for this page to automatically refresh, or go to http://www.epa.gov/region09/waste/sfund/prg/index.htm

U.S. Environmental Protection Agency

Region 9: Superfund

Serving Arizona, California, Hawaii, Nevada, the Pacific Islands, and over 140 Tribal Nations

Preliminary Remediation Goals

Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements. The PRGs contained in the Region 9 PRG Table are generic; they are calculated without site specific information. However, they may be re-calculated using site specific data.

PRGs should be viewed as Agency guidelines, not legally enforceable standards. They are used for site "screening" and as initial cleanup goals if applicable. PRGs are not *de facto* cleanup standards and should not be applied as such. However, they are helpful in providing long-term targets to use during the analysis of different remedial alternatives. By developing PRGs early in the decision-making process, design staff may be able to streamline the consideration of remedial alternatives.

- **What's New in 2002**
- **User's Guide/Technical Background Document** (158 K PDF)
- **Frequently Asked Questions About the PRG Tables**
- **Useful Toxicology/Risk Assessment Links**

Region 9 PRGs 2002 Table (130 K PDF)
A summary table that presents the final list of generic PRG (for soil, air, and water) selected for site screening in Region 9. Also available as a Microsoft Excel file (1.1 M XLS).

InterCalc Tables (144 K PDF): present additional information not

available in the R9 PRG Table above.

- **Soil Calculations** (74 K PDF): lists pathway-specific values for soils under residential and industrial land-use scenarios.
- **Air-Water Calculations** (50 K PDF): lists pathway-specific values for air and water assuming a residential exposure scenario
- **Phys-Chem Data** (23 K PDF): includes volatilization factors (VF) and soil saturation values (SAT) for VOCs only.

DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY, WEST
NAVAL FACILITIES ENGINEERING COMMAND
2001 JUNIPERO SERRA BOULEVARD, SUITE 600
DALY CITY, CALIFORNIA 94014-1976

IN REPLY REFER TO:
Ser 052SFT
29 April 2003

Mr. Phillip A. Ramsey
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105

Subj: MINUTES TO 20 MARCH 2003 INFORMAL DISPUTE RESOLUTION MEETING SITES 13 AND 17 RECORD OF DECISION; AND DRAFT FINAL FIVE-YEAR PERIODIC REVIEW ASSESSEMENT, LITIGATION AREA NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Encl: (1) Minutes to 20 March 2003 Informal Dispute Resolution Meeting, Sites 13 and 17 Record of Decision; and Draft Final Five-Year Periodic Review Assessment, Litigation Area Naval Weapons Station Seal Beach Detachment Concord, California

1. The enclosed minutes are provided for your records. As always, if there are any questions regarding these minutes, feel free to contact me at 650-746-7451 or by e-mail: tyahlasf@efawest.navfac.navy.mil.

Sincerely

Stephen F. Tyahla, P.E., CHMM
Lead Remedial Project Manager

Distribution:
U.S. Environmental Protection Agency, Region 9 (Attn: Mr. Phillip A. Ramsey)
U.S. Environmental Protection Agency, Region 9 (Attn: Sonce de Vries)
U.S. Fish and Wildlife Services (Attn: James Haas)
National Oceanic and Atmospheric Administration (Attn: Denise Klimas)
National Oceanic and Atmospheric Administration (Attn: Laurie Sullivan)
California Department of Toxic Substances Control Region 1 (Attn: Jim Pinasco)
California Department of Toxic Substances Control Region 1 (Attn: John Christopher)

29 April 2003

Subj: MINUTES TO 20 MARCH 2003 INFORMAL DISPUTE RESOLUTION MEETING SITES 13 AND 17 RECORD OF DECISION; AND DRAFT FINAL FIVE-YEAR PERIODIC REVIEW ASSESSEMENT, LITIGATION AREA NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

Distribution (Continued)
California Regional Water Quality Control Board, SFBAY (Attn: Laurent Meillier)
California Department of Fish and Game (Attn: Jim Hardwick)
CNRSW (Attn: Theresa Morley)
NWS SB Detachment Concord (Attn: David Baillie)
Restoration Advisory Board (RAB) Co-Chair (Attn: Ms. Mary Lou Williams)

Copy to:
RAB Member Marcus O'Connell
RAB Member David Griffith
RAB Member Ed McGee
RAB Member Mario Menesini
RAB Member Ray O'Brien
RAB Member Igor O. Skaredoff
RAB Member Gene Sylls
RAB Member Gay Tanasescu
Tech Law, Inc. (Attn: Hilary Waites)
TtEMI San Francisco (2) (Attn: Mary Gleason)
TtEMI San Francisco (2) (Attn: Joanna Canepa)
Engineering Field Activity West (Attn: Roger Green)
Engineering Field Activity West (4) (Attn: Tony Tactay/Info. Rep/Admin Record/NWS SBD Concord files)
Weston Solutions, Inc. (Attn. Claudette Altamirano)

INFORMAL DISPUTE RESOLUTION MEETING

SITES 13 AND 17 RECORD OF DECISION AND DRAFT FINAL FIVE-YEAR PERIODIC REVIEW ASSESSEMENT, LITIGATION AREA

NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

March 20, 2003

These minutes reflect general issues raised, agreements reached, and action items identified at the informal dispute resolution meeting for the Sites 13 and 17 record of decision (ROD) and the draft final "Five-Year Periodic Review Assessment for the Litigation Area at the Naval Weapons Station Seal Beach Detachment Concord, California" (hereinafter referred to as the draft final five-year review). The meeting took place from 1:00 p.m. to 4:00 p.m. on March 20, 2003, at Tetra Tech EM Inc. (TtEMI) offices in San Francisco, California. A list of participants and their affiliations is included as Attachment A. The meeting agenda is included as Attachment B.

I. OPENING STATEMENTS

Phillip Ramsey (U.S. Environmental Protection Agency [EPA]) explained that this meeting should focus on the issues in dispute: the ROD for Sites 13 and 17 and the draft final five-year review. Stephen Tyahla (U.S. Department of the Navy [Navy]) introduced himself as the new lead Navy Remedial Project Manager (RPM); Michelle Shutz (EPA) welcomed Mr. Tyahla to the Concord team. Because Ms. Shutz was not able to stay for the entire meeting, the agenda item regarding the schedules was the first item of discussion.

II. SCHEDULES (SITE MANAGEMENT PLAN)

Ms. Shutz explained the importance of meeting deadlines and keeping to the schedule. She said that EPA would prefer to not undergo full site management plan (SMP) negotiations each year. Rich Faris (Naval Facilities Engineering Command, Engineering Field Activity West [EFA West]) and Karen Goldberg (EPA) both agreed that the schedule does need to be renegotiated each year in accordance with the federal facilities agreement (FFA). Ms. Goldberg said that, if appropriate, the schedule from the previous year could be resubmitted with the inclusion of a statement indicating no changes. Mr. Tyahla said that he intends to develop the best possible schedule, but because scheduling tends to be an ongoing and dynamic process, he would like to implement the use of Microsoft Project Planner (MPP) (project management/scheduling software) for the SMP; this would allow the impacts of suggested schedule changes to be viewed immediately. Laurent Meillier (California Regional Water Quality Control Board [RWQCB]) and Mr. Ramsey did not think that Microsoft Project was available to them at their offices. Mr. Tyahla requested that they let him know what project management software is available to them. He also indicated that printouts from MPP can be in *.pdf file format thus allowing them to receive electronic copies without owning the MPP software.

Mr. Tyahla said that it is his intention to keep the agencies well informed of any possible schedule changes or issues as they arise. Mr. Ramsey and Mr. Tyahla both agreed to meet in the future to prioritize sites and discuss the SMP so as make the most effective and efficient use of time and money. Mr. Ramsey and Ms. Shutz expressed their appreciation for Mr. Tyahla's statements regarding scheduling, prioritizing sites, and increasing communication with the agencies.

III. SITE 13 AND 17 DISCUSSION

The draft Navy letter submitted to the agencies on March 19, 2003 was discussed regarding the proposed sampling of perchlorate and explosives at Site 13. The group discussed what concentration of perchlorate would warrant concern. Ms. Shutz said that because the regulatory standards for perchlorate are being developed, EPA might not sign a final ROD for the site, even should the perchlorate concentrations be non-detect. The current EPA position on RODs for perchlorate is to sign an "interim ROD." She explained that interim RODs are typically used when regulatory values are not certain; an interim ROD allows some latitude while enabling the project to move forward with the remedial design. While an interim ROD looks like a final ROD, it acknowledges that eventually a final ROD will be submitted.

Mr. Ramsey requested that the Navy revise their March 19, 2003, letter to remove any discussion of acceptable levels of perchlorate. Mr. Tyahla said that the revised letter would be accompanied by an addendum to an existing final sampling and analysis plan (SAP) for agency review. Mr. Tyahla agreed to revise the letter and will reissue the letter after the relevant SAP addendum has been prepared. Ms. Gleason stressed that the data quality objectives (DQO) may require that a screening value for perchlorate be determined before the sampling. Rich Faris (Navy) asked what concentration of perchlorate in groundwater would warrant EPA concern. Ms. Shutz said that a human fetus might be affected at 1 part per billion (ppb). The EPA agreed to notify the Navy about any RODs signed by EPA that address sites with perchlorate issues.

Mr. Ramsey asked about the detection limits for the explosives using EPA method 8330. Jerry Wickham (TtEMI) stated that the detection limits for most analytes in the two groundwater samples previously analyzed at Site 13 using EPA method 8330 were below 1 ppb. Therefore, it should be possible to achieve detection limits below the 2002 EPA preliminary remediation goals for tap water (EPA 2002).

IV. LITIGATION FIVE-YEAR REVIEW DISCUSSION

The group discussed EPA comments 4, 2, and 9 on the draft final five-year review. EPA comments 4, 2, and 9 are included as Attachment C.

Discussions Regarding EPA Comment 4

Mr. Ramsey said he wished to discuss three issues related to the draft final five-year review, the most significant of which concerns monitoring at the site. The EPA stated that although they are relatively happy with the draft final five-year review, there is concern about future monitoring. Mr. Tyahla said that the Navy agrees to conduct periodic monitoring based on a focused monitoring plan to be developed in consultation with the agencies using the DQO process. Ms. Gleason said that the Navy would agree to rewrite the discussion of future monitoring in the final five-year review and suggested that a new monitoring plan should be developed. Hilary Waites (Tech Law, Inc.) agreed and suggested that the focus should be on continued monitoring needs until further construction rather than a monitoring plan for the next 10 years. Subsequent to finalization of the five-year review, the Navy and agencies will arrange a meeting to discuss development of a monitoring plan for the Litigation Area.

Discussions regarding EPA Comments 2 and 9

Ms. Gleason explained that physical data were being gathered and that a file review was being conducted to investigate migration of contamination to the Litigation Area from off-site sources; if significant contamination is coming onto the site, the source should be controlled before the cleanup of the site. The Navy agreed to change the language in the final five-year review report to indicate that the Navy will

assess the significance of offsite sources before making a determination about additional remedial actions. The Navy agreed to submit draft responses to comments on the draft final five-year review and draft proposed text revisions for the report before finalizing the five-year report.

Discussions Regarding Three New Installation Restoration Sites

Mr. Tyahla proposed the creation of three new installation restoration (IR) sites for Units 7, 11, and 13. Ms. Gleason explained that because the three sites would require three different remedial actions, it would make sense to create three separate feasibility studies (FS) to evaluate alternatives. Mr. Tyahla suggested that if the agencies were concerned about the generation of three separate reports, the FSs could be combined into one report with three different sections discussing the alternatives for each new IR site. Ms. Shutz agreed that the creation of three new IR sites may be workable; however, a well-documented paper trail should be established stating why three documents or three IR sites would be more effective and efficient than one document or one site. Ms. Shutz suggested that it would be appropriate to document the decision to create three new IR sites in the final five-year-review. Mr. Meillier stated that he would need to confer with the RWQCB management to determine the regulatory impact(s) of this Navy proposal. Mr. Meillier preliminarily affirmed that it would be essential to treat these sites holistically within the careful analysis of their ecosystemic relationships to the adjacent parcels. Furthermore, Mr. Meillier supported the inclusion of these three feasibility studies into one single report as recommended by Mr. Tyahla.

It was decided that after internal agency discussions and before the submittal of the final five-year review, the agencies would provide the Navy with input on whether they support the proposed creation of three new IR sites at the Litigation Area. Concurrent with the submittal of the draft responses to agency comments on the draft final five-year review, the Navy will e-mail the agencies to explain the benefits of creating three new IR sites at the Litigation Area.
Mr. Ramsey proposed a boat tour of Lost Slough. The EPA and Navy will coordinate to plan a Lost Slough boat tour if feasible.

Joanna Canepa (TtEMI) said that National Oceanic and Atmospheric Administration comments on the draft final five-year review were received today; however, California Environmental Protection Agency Department of Toxic Substances Control (DTSC) comments have not yet been submitted. It was requested that DTSC submit comments on the report. Jim Pinasco (DTSC) confirmed that DTSC comments would be submitted within the next several days.

It was agreed that the informal dispute would be resolved with the EPA approval of the final five-year review report.

V. ACTION ITEMS

The following action items were generated during the informal dispute resolution meeting. This list has been updated to reflect actions taken as of 8 April 2003.

	Action Items	**Follow Up**
1	The EPA and the DTSC will notify the Navy about what project management software is available to them (for example, Microsoft Project).	

	Action Items	Follow Up
2	The Navy and agency project managers will meet to discuss the site management plan.	Plan of Action developed 26 March; next meeting set for 16 April 03
3	The Navy will revise the March 19, 2003, draft perchlorate sampling letter for Sites 13 and 17 to remove the discussion of perchlorate levels of concern and will issue the letter after the relevant SAP addendum has been prepared.	SAP development in progress
4	The EPA will notify the Navy about any RODs signed by EPA that address perchlorate.	
5	The EPA and Navy will coordinate to plan a Lost Slough boat tour if feasible.	
6	DTSC will submit comments on the draft final five-year review for the Litigation Area.	Completed 20 March 03
7	Subsequent to finalization of the five-year review, the Navy and agencies will arrange a meeting to discuss development of a monitoring plan for the Litigation Area.	
8	The Navy will submit draft responses to comments on the draft final five-year review for the Litigation Area and will provide proposed text revisions for the report.	Completed 8 April 03
9	The Navy will e-mail the agencies an explanation of the benefits of creating three new IR sites at the Litigation Area. This will be concurrent with the draft responses to comments.	
10	After internal agency discussions and before the submittal of the final five-year review for the Litigation Area, the agencies will provide the Navy with input on the proposed creation of three new IR sites at the Litigation Area.	Completed 8 April 03

VI. REFERENCES

U.S. Environmental Protection Agency (EPA). 2002. "Region IX Preliminary Remediation Goals 2002." November.

ATTACHMENT A

ATTENDEES AND AFFILIATIONS
INFORMAL DISPUTE RESOLUTION MEETING

March 20, 2003

(One Page)

ATTENDEES AND AFFILIATIONS

INFORMAL DISPUTE RESOLUTION MEETING

March 20, 2003

Name	Affiliation	Telephone
Rich Faris	Navy EFA West	(650) 746-7450
Roger Green	Navy counsel, EFA West	(650) 746-7311
Stephen Tyahla	Lead RPM, effective March 10, 2003, Navy EFA West	(650) 746-7451
Jim Pinasco (via telephone)	DTSC	(916) 255-3719
Denise Klimas (via telephone)	DTSC/NOAA	(916) 255-6686
Sonce de Vries	EPA/USFWS	(415) 972-3061
Karen Goldberg	EPA	(415) 972-3951
Phillip Ramsey	EPA	(415) 972-3006
Michelle Shutz	EPA counsel	(415) 972-3021
Laurent Meillier	RWQCB	(510) 622-2440
Hilary Waites	Tech Law	(415) 281-8730, Extension 13
Joanna Canepa	TtEMI	(415) 222-8362
Mary Gleason	TtEMI	(415) 222-8319
Michelle Murphy	TtEMI	(415) 222-8235
Jerry Wickham	TtEMI	(415) 222-8207

Notes:

DTSC	Department of Toxic Substances Control
EFA West	Naval Facilities Engineering Command, Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
NOAA	National Oceanic and Atmospheric Administration
RPM	Remedial project manager
RWQCB	California Regional Water Quality Control Board
TtEMI	Tetra Tech EM Inc.
Tech Law	Tech Law Inc.
USFWS	U.S. Fish and Wildlife Service

ATTACHMENT B

FINAL AGENDA
INFORMAL DISPUTE RESOLUTION MEETING

March 20, 2003

(One Page)

AGENDA

INFORMAL DISPUTE RESOLUTION MEETING
Naval Weapons Station Seal Beach Detachment Concord
Thursday, March 20 2003, 1:00 p.m. - 4:00 p.m.
Tetra Tech EM Inc.
135 Main Street
San Francisco, CA

Introductions (5 minutes)

Opening Statements (10 minutes)

Site 13 Discussion: (20 minutes)
Navy update on Site 13 position
DTSC position/response
RWQCB position/response
U.S. EPA position/response
Summarize/action items

Litigation Area Five- Year Report Discussion: (1 hour)
U.S. EPA to summarize major comments:
Outstanding issues:
Navy position/response
DTSC position/response
RWQCB position/response
U.S.EPA position/response
Summarize/action items

Schedules (SMP) (30 minutes)

Closing Remarks

ATTACHMENT C

EPA COMMENTS 4, 2, AND 9 ON THE DRAFT FINAL FIVE-YEAR REVIEW REPORT INFORMAL DISPUTE RESOLUTION MEETING

March 20, 2003

(Five Pages)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

December 20, 2002

Mr. Gilbert Rivera
Department of the Navy
Engineering Field Activity West
Pacific Plaza
2001 Junipero Serra Boulevard, Suite 600
Daly City, CA 94014-1976

Re: U.S. EPA Review of Concord Litigation Area Five-Year Assessment Report

Dear Mr. Rivera:

The U.S. Environmental Protection Agency (U.S. EPA) has received and reviewed a document entitled, "Draft Final Five-Year Periodic Assessment for the Litigation Area at Naval Weapons Station Seal Beach Detachment Concord, California", dated October 23, 2002 ("draft final Five-Year Report"). The draft final Five-Year Report was prepared by TetraTech EM Inc. on behalf of the Department of the Navy (Navy). Based upon U.S. EPA's review, the following comments apply:

1. Despite improvements made to the draft final Five-Year Report in response to regulatory agencies' comments and technical meetings conducted in February and March of 2002, there are still outstanding issues that must be resolved in order for U.S. EPA to approve the draft final Five-Year Report. Pursuant to the Federal Facilities Agreement (FFA), Section 22, Dispute Resolution, U.S. EPA hereby initiates an informal dispute with the Navy on the draft final Five-Year Report. As a way to informally resolve this dispute and as described in the FFA, U.S. EPA is available and would like to meet with the Navy as soon as possible to discuss our concerns which are detailed below.

2. The draft final Five-Year Report concludes that the remedy at the Litigation Area (or site) is not fully protective, yet the report also states that additional remedial action should not be performed until "ongoing contamination of the site by off-site sources is fully addressed." This statement is repeated in Section 10.0 (page 10-1), Section 10.3 (page 10-8), and Section 10.3.2.2 (page 10-13). Consistent with Agency guidance ("Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites" OSWER Directive 9285.6-08, February 12, 2002) and as described in past discussions with the Navy on the site, U.S. EPA does not concur that it is

appropriate to delay action where significant onsite contamination exists until all off-site sources have been fully addressed. First, in some cases, offsite sources may not represent *significant* ongoing sources of contamination and/or may not pose significant risk relative to chemicals already present onsite that warrant additional action. Second, Navy policy cited in the draft final Five-Year Report ("Policy on Sediment Site Investigation and Response Action") does not state that the Navy should delay response action if there are non-Navy sources of contamination. [1] Third, the Navy should identify the steps necessary to (a) investigate the risk(s) associated with these off-site sources, and (b) ensure that the parties responsible for any unacceptable risk take the necessary response action(s). Finally, the Navy should determine what response actions required by the parties to the existing Consent Decrees have not been completed and take appropriate action to ensure that these actions are completed.

3. With regard to three supplemental feasibility studies proposed in Section 10.3 to address deficiencies in the remedy, the text on page 10-8 states, "[t]he three supplemental feasibility studies will be conducted only when the Navy has determined that significant off-site sources have been addressed... ." This is contrary to the recently completed draft final Site Management Plan, dated December 2, 2002, (SMP), which indicates that the Navy will submit a draft supplemental feasibility study report to regulatory agencies on November 27, 2003. Please resolve this discrepancy. Please note that the Navy must follow the procedures in the Federal Facilities Agreement (FFA) to extend any scheduled deadline in the SMP.

4. Section 10.1, Recommendations On Future Monitoring, Pages 10-2 to 10-3: First, the recommendation to discontinue all annual monitoring activities is not supported by the information presented in the report. Given the uncertainties regarding the extent of contamination migrating from offsite sources, it does not appear to be appropriate to forego all annual monitoring activities until additional remedial actions are conducted. As stated in the February 22, 2002, Risk Management Meeting minutes (included in Appendix H, under Monitoring on page 4), "[the Navy contractor] summarized by stating the Navy and the agencies agreed to defer the

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[1]**Rather, the policy provides that "[i]f it is determined that a significant source of contamination is not coming from Navy sources, document the information, inform the regulators (using the Watershed Contaminated Source Document), consult with counsel for appropriate action and inform Naval Facilities Engineering Command (NAVFAC), if necessary." (p. 3), and later goes on to state that "[o]nce the extent of the Navy responsibility has been identified and there is potential re-contamination from non-Navy source(s) it shall be documented in the investigation report, the Record of Decision before any response action is undertaken and in the response action completion report."(p.5) These provisions indicate that the Navy should investigate possible non-Navy sources of contamination, but do not suggest delaying responses to Navy sources of contamination. Finally, the Policy does not supersede the Navy's responsibility to protect human health and the environment under CERCLA.**

annual monitoring discussion until a later date. [the Navy contractor] indicated that in the meantime, the Navy would work toward addressing data gaps in the supplemental feasibility study." It is recommended that periodic monitoring of metal concentrations in sediment in ditches and sloughs, surface water, and groundwater be conducted until further remedial actions are implemented in Remedial Action Subsite (RASS) 1 and RASS 3. Additionally, the restored areas of RASS 1, 2, and 3 should be inspected to ensure the continued success of revegetation and to identify any areas of stressed vegetation. U.S. EPA requests that the Section 10.1 of the report be revised to delete the bullet regarding discontinuing annual monitoring, and revising the last two sentences of the first paragraph in that Section to read as follows: "In addition, the Navy plans to conduct sampling to monitor conditions at the site in the future. As part of the development of the monitoring plan using the DQO process, the Navy will meet with the regulatory agencies this year to determine monitoring requirements, and will include the monitoring plan in the next annual Amendment of the SMP."

Second, this section lacks sufficient detail regarding the types of monitoring activities that will be conducted in the future. Several types of data are necessary in order to evaluate the protectiveness of the remedy in the future. These include: 1) monitoring of endangered species, as recommended in Section 10.4 of the Draft version of the report, which stated that continued monitoring of populations of endangered species known to use the site is recommended, 2) monitoring of concentrations of metals in surface water, since metals were detected at concentrations exceeding State of California promulgated surface water criteria in every habitat unit, and these concentrations pose potential risk to aquatic receptors onsite, as well as Suisun Bay as they migrate offsite, 3) monitoring near actively remediated area, as referred to in the Navy's response to EPA Comment 3 on the Draft version of the report, in which the Navy acknowledged that continued monitoring of the marsh surface in RASS 1 west of the actively remediated area is warranted because contamination has been left in place, and 4) collecting sediment cores to evaluate the vertical profile of contamination, as requested by comments on the Draft version of the report submitted by California Department of Toxic Substances Control (DTSC) requesting that the vertical profile of contamination in sediment cores be periodically examined in the future to demonstrate that the assumption that sediment accretes on the marsh surface (thus slowly blocking the potential exposure pathway for contact of ecological receptors with contamination) is still valid.

5. Section 10.2, Recommendations for Additional Sampling to Address Data Gaps, Page 10-3: The additional investigations described in the text and depicted in Figure 95 appear to be consistent with discussions between the Navy and regulatory agencies during meetings on February 22 and March 27, 2002. Pursuant to the FFA and SMP, the regulatory agencies will have the opportunity to comment on the Sampling and Analysis Plan (SAP), which will provide a more detailed description of the proposed additional sampling

efforts. Pursuant to the SMP, the draft SAP will be submitted for U.S. EPA review on February 14, 2003.

6. Section 10.2.5, RASS 4 Semilithified Soil Sampling: The Navy proposes to collect three samples of semilithified or ashy soil and analyze it for metals, semivolatiles, PCBs, pesticides, organic carbon, and pH. However, U.S. EPA has also requested in various meetings with the Navy that the semilithified soil in RASS 4 be subject to a radioactivity survey because it appears to resemble flyash, which is also present on other sites at Concord Naval Weapons Station. While U.S. EPA recognizes that the Navy has done an initial radioactivity screening effort at neighboring site Area of Concern (AOC) 1, which appeared to indicate that this material was not radioactive, the Navy should conduct an additional screening effort at the area of semilithified soil in RASS 4.

7. Section 10.3, Recommendations to Protect Human Health and the Environment at the Site, Page 10-8: According to U.S. EPA Guidance, the Recommendations section of the draft final Five-Year Report should identify the party responsible for implementation, the agency (or agencies) with oversight authority, a recommended schedule for implementation and completion, and the impact, if any, on current or future protectiveness. Please revise the report to provide specific information regarding each of these items, and/or a summary table listing recommendations and follow-up actions.

8. Land Use Controls: The Navy should include in the supplemental feasibility study report an evaluation of institutional controls necessary to protect human health and the environment during implementation of any additional response actions and thereafter.

9. U.S. EPA understands that the Navy's general position is that offsite (non-Navy) contamination which may be mobilized represents a threat to Litigation Areas RASS 1 and 3 that are currently contaminated. Given this position, a similar threat also exists for RASS Area 2 (Navy remedy currently protective) where cleanup action has not been completed at the adjacent Atchison Topeka Santa Fe Railway Remedial Action Area. As a result, the Navy should continue monitoring of this site property to ensure that contaminants remaining in place are not mobilized prior to or during the remaining response actions at RASS 2.

10 In Sections 10.3.1. through 10.3.3, regulatory agency staff and natural resource trustees should be included as authorized personnel allowed to enter the Litigation Area.

If you have any questions concerning this matter, please contact me at (415) 972-3006.

Sincerely,

Phillip Ramsey
Remedial Project Manager

cc: Mr. Jim Pinasco, DTSC
Mr. Laurent Meillier, RWQC
Mr. Marcus O'Connell, Restoration Advisory Board

RESPONSES TO REGULATORY AGENCY COMMENTS ON DRAFT FINAL FIVE-YEAR PERIODIC REVIEW ASSESSMENT REPORT FOR THE CONCORD LITIGATION AREA, NAVAL WEAPONS STATION SEAL BEACH DETACHMENT (NWSSBD) CONCORD, CONCORD, CALIFORNIA

This document presents the U.S. Department of the Navy's (Navy) responses to comments from the U.S. Environmental Protection Agency (EPA), the California Regional Water Quality Control Board (RWQCB), the National Oceanic and Atmospheric Administration (NOAA), and the Department of Toxic Substances Control (DTSC) on the Draft Final Five-Year Periodic Review Assessment for the Litigation Area at the Naval Weapons Station, Seal Beach Detachment Concord, Concord, California, dated October 23, 2002. The comments addressed below were received from EPA on December 20, 2002; from the RWQCB on December 18, 2002; from NOAA on March 20, 2003; and from DTSC on March 27, 2003. The comments from NOAA were received in letter format; a general response to the letter is provided.

RESPONSES TO EPA COMMENTS

1. **Comment:** **Despite improvements made to the draft final Five-Year Report in response to regulatory agencies' comments and technical meetings conducted in February and March of 2002, there are still outstanding issues that must be resolved in order for U.S. EPA to approve the draft final Five-Year Report. Pursuant to the Federal Facilities Agreement (FFA), Section 22, Dispute Resolution, U.S. EPA hereby initiates an informal dispute with the Navy on the draft final Five-Year Report. As a way to informally resolve this dispute and as described in the FFA, U.S. EPA is available and would like to meet with the Navy as soon as possible to discuss our concerns which are detailed below.**

   Response: The Navy met with the EPA, DTSC, and RWQCB on March 20, 2003 to discuss the outstanding issues regarding the five-year review report, and the concerns that were summarized in EPA's comments. A list of action items and focused issues requiring further discussion were generated at this meeting; that list is attached for convenience. In response to one of the action items, the Navy is submitting this draft responses to comments and proposed changes to the draft final five-year review report; thisshould allow EPA to determine whether the informal dispute can be resolved by means of finalizing the report with these proposed responses and changes . Please note for the final version of the five-year periodic review assessment report, the Navy plans to only issue replacement pages for the main body of the text and not an entirely new report.

2. Comment: **The draft final Five-Year Report concludes that the remedy at the Litigation Area (or site) is not fully protective, yet the report also states that additional remedial action should not be performed until "ongoing contamination of the site by off-site sources is fully addressed." This statement is repeated in Section 10.0 (page 10-1), Section 10.3 (page 10-8), and Section 10.3.2.2 (page 10-13). Consistent with Agency guidance ("Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites" OSWER Directive 9285.6-08, February 12, 2002) and as described in past discussions with the Navy on the site, U.S. EPA does not concur that it is appropriate to delay action where significant onsite contamination exists until all off-site sources have been fully addressed. First, in some cases, offsite sources may not represent *significant* ongoing sources of contamination and/or may not pose significant risk relative to chemicals already present onsite that warrant additional action. Second, Navy policy cited in the draft final Five-Year Report ("Policy on Sediment Site Investigation and Response Action") does not state that the Navy should delay response action if there are non-Navy sources of contamination.[1] Third, the Navy should identify the steps necessary to (a) investigate the risk(s) associated with these off-site sources, and (b) ensure that the parties responsible for any unacceptable risk take the necessary response action(s). Finally, the Navy should determine what response actions required by the parties to the existing Consent Decrees have not been completed and take appropriate action to ensure that these actions are completed.**

Response: The Navy will revise the report to state that remedial actions will not be initiated until the significance of offsite sources has been fully assessed. The Navy is planning to conduct a "data gaps evaluation" for the Litigation Area. The Draft Sampling and Analysis Plan for this work was submitted to the agencies for review on March 28, 2003. This investigation was designed to assess the *significance* of potential offsite sources that may be currently re-contaminating Navy property. The data gaps evaluation also includes a file review of the status of current investigations, ongoing remedial activities and existing levels of contamination at neighboring properties. The file review will include an assessment of whether parties to the existing consent decrees have

[1] Rather, the policy provides that "[i]f it is determined that a significant source of contamination is not coming from Navy sources, document the information, inform the regulators (using the Watershed Contaminated Source Document), consult with counsel for appropriate action and inform Naval Facilities Engineering Command (NAVFAC), if necessary." (p. 3), and later goes on to state that "[o]nce the extent of the Navy responsibility has been identified and there is potential re-contamination from non-Navy source(s) it shall be documented in the investigation report, the Record of Decision before any response action is undertaken and in the response action completion report."(p.5) These provisions indicate that the Navy should investigate possible non-Navy sources of contamination, but do not suggest delaying responses to Navy sources of contamination. Finally, the Policy does not supersede the Navy's responsibility to protect human health and the environment under CERCLA.

complied with conditions of those decrees (i.e., whether they have completed their required remediation and controlled their sources to prevent re-contamination of Navy property).

The Navy has agreed to conduct supplemental feasibility studies (FSs) of three areas (Unit 7 mosquito ditches, Unit 11 slough, and Unit 13 Nichols Creek) concurrent with the data gaps evaluation. These supplemental FSs must be scoped, awarded, and initiated. The Navy will work with the agencies to make sure their concerns are addressed by the scope of the supplemental FSs. The Navy has decided to establish three new Installation Restoration (IR) Program sites (Sites 32, 33, and 34) for these three areas. With the planned supplemental FSs, they will begin in the feasibility study stage, using existing data as well as data obtained during the forthcoming "data gaps" investigation. Creating new IR sites will facilitate the Navy's ability to obtain and direct limited resources on areas of highest concern.

The Navy does not believe that initiating remedial actions when *significant* offsite sources are still re-contaminating Navy property is the best use of limited remedial action funds, nor is such action technically defensible. Based on the results of the data gaps evaluation and the supplemental FSs, the Navy will make a determination on whether remedial actions are warranted in these three areas and what types of actions are most feasible. If *significant* offsite sources are present and are re-contaminating these areas, the Navy will not proceed with remedial actions in affected areas until these offsite sources are controlled.

3. Comment: **With regard to three supplemental feasibility studies proposed in Section 10.3 to address deficiencies in the remedy, the text on page 10-8 states, "[t]he three supplemental feasibility studies will be conducted only when the Navy has determined that significant off-site sources have been addressed... ." This is contrary to the recently completed draft final Site Management Plan, dated December 2, 2002, (SMP), which indicates that the Navy will submit a draft supplemental feasibility study report to regulatory agencies on November 27, 2003. Please resolve this discrepancy. Please note that the Navy must follow the procedures in the Federal Facilities Agreement (FFA) to extend any scheduled deadline in the SMP.**

Response: Please see response to EPA Comment # 2. The Navy is planning to begin the supplemental FSs this year and will work with the EPA to review the currently scheduled submittal date for these documents in the site management plan (SMP).

4. Comment: **<u>Section 10.1, Recommendations On Future Monitoring, Pages 10-2 to 10-3</u>: First, the recommendation to discontinue all annual monitoring activities is not supported by the information presented in the report.**

Given the uncertainties regarding the extent of contamination migrating from offsite sources, it does not appear to be appropriate to forego all annual monitoring activities until additional remedial actions are conducted. As stated in the February 22, 2002, Risk Management Meeting minutes (included in Appendix H, under Monitoring on page 4), "[the Navy contractor] summarized by stating the Navy and the agencies agreed to defer the annual monitoring discussion until a later date. [the Navy contractor] indicated that in the meantime, the Navy would work toward addressing data gaps in the supplemental feasibility study." It is recommended that periodic monitoring of metal concentrations in sediment in ditches and sloughs, surface water, and groundwater be conducted until further remedial actions are implemented in Remedial Action Subsite (RASS) 1 and RASS 3. Additionally, the restored areas of RASS 1, 2, and 3 should be inspected to ensure the continued success of revegetation and to identify any areas of stressed vegetation. U.S. EPA requests that the Section 10.1 of the report be revised to delete the bullet regarding discontinuing annual monitoring, and revising the last two sentences of the first paragraph in that Section to read as follows: "In addition, the Navy plans to conduct sampling to monitor conditions at the site in the future. As part of the development of the monitoring plan using the DQO process, the Navy will meet with the regulatory agencies this year to determine monitoring requirements, and will include the monitoring plan in the next annual Amendment of the SMP."

Second, this section lacks sufficient detail regarding the types of monitoring activities that will be conducted in the future. Several types of data are necessary in order to evaluate the protectiveness of the remedy in the future. These include: 1) monitoring of endangered species, as recommended in Section 10.4 of the Draft version of the report, which stated that continued monitoring of populations of endangered species known to use the site is recommended, 2) monitoring of concentrations of metals in surface water, since metals were detected at concentrations exceeding State of California promulgated surface water criteria in every habitat unit, and these concentrations pose potential risk to aquatic receptors onsite, as well as Suisun Bay as they migrate offsite, 3) monitoring near actively remediated area, as referred to in the Navy's response to EPA Comment 3 on the Draft version of the report, in which the Navy acknowledged that continued monitoring of the marsh surface in RASS 1 west of the actively remediated area is warranted because contamination has been left in place, and 4) collecting sediment cores to evaluate the vertical profile of contamination, as requested by comments on the Draft version of the report submitted by California Department of Toxic Substances Control (DTSC) requesting that the vertical profile of contamination in sediment cores be periodically

examined in the future to demonstrate that the assumption that sediment accretes on the marsh surface (thus slowly blocking the potential exposure pathway for contact of ecological receptors with contamination) is still valid.

Response: The Navy agrees that periodic limited monitoring is required due to the ongoing presence of contaminants at the site. The Navy's recommendation to discontinue intensive annual monitoring on the scale that had been conducted for five years after remediation is consistent with the original monitoring plan and also consistent with discussions with the agencies about focusing future monitoring on areas of highest concern for ecological risk or migration of contaminants.

The Navy believes that future monitoring should be focused and designed to maximize use of the results of the five years of intensive post-remediation monitoring so that significant changes at the site can be detected. The Navy plans to develop a new monitoring plan for periodic future monitoring using the data quality objective (DQO) process with clear exit criteria or triggers for future actions. The frequency and intensity of monitoring and the parameters to be monitored will be determined with the regulatory and trustee agencies.

The Navy agrees to revise Section 10.1 of the report by deleting the bullet regarding discontinuing annual monitoring and to add the requested statement. The Navy does not agree that the final five-year review report should include the details on the future monitoring, as that will depend on the monitoring objectives and DQOs determined in collaboration with the agencies. The Navy recommends that a new, separate monitoring plan be developed and the Navy looks forward to meeting with the agency representatives this year to discuss the details of this future monitoring.

5. Comment: **Section 10.2, Recommendations for Additional Sampling to Address Data Gaps, Page 10-3: The additional investigations described in the text and depicted in Figure 95 appear to be consistent with discussions between the Navy and regulatory agencies during meetings on February 22 and March 27, 2002. Pursuant to the FFA and SMP, the regulatory agencies will have the opportunity to comment on the Sampling and Analysis Plan (SAP), which will provide a more detailed description of the proposed additional sampling efforts. Pursuant to the SMP, the draft SAP will be submitted for U.S. EPA review on February 14, 2003.**

Response: Due to funding and contractual constraints, the SAP was not completed by February 14, 2003; on February 7, 2003 the Navy sent a letter to EPA project manager, Mr. Phillip Ramsey, requesting an extension to the SMP schedule for submittal of the draft SAP by March 29, 2003. EPA concurred with the revised schedule verbally at a Remedial Project Manager's meeting

on February 25, 2003. The draft SAP was submitted to the agencies for their review on March 28, 2003 (Tetra Tech EM, Inc [TtEMI] 2003a).

6. **Comment:** **<u>Section 10.2.5, RASS 4 Semilithified Soil Sampling</u>: The Navy proposes to collect three samples of semilithified or ashy soil and analyze it for metals, semivolatiles, PCBs, pesticides, organic carbon, and pH. However, U.S. EPA has also requested in various meetings with the Navy that the semilithified soil in RASS 4 be subject to a radioactivity survey because it appears to resemble flyash, which is also present on other sites at Concord Naval Weapons Station. While U.S. EPA recognizes that the Navy has done an initial radioactivity screening effort at neighboring site Area of Concern (AOC) 1, which appeared to indicate that this material was not radioactive, the Navy should conduct an additional screening effort at the area of semilithified soil in RASS 4.**

Response: During the radiological screening of AOC 1, two areas of bare soil in the motorcycle tracks in RASS 4 were also surveyed. No significant radiological findings were made. A summary of the results for the RASS 4 samples was presented in the AOC 1 close-out report (TtEMI 2003b). At this time, the Navy is not proposing further radiological surveys of RASS 4; if chemical analysis of the ashy soils confirms a potential flyash source for the material, additional radiological screening may be conducted.

7. **Comment:** **<u>Section 10.3, Recommendations to Protect Human Health and the Environment at the Site, Page 10-8</u>: According to U.S. EPA Guidance, the Recommendations section of the draft final Five-Year Report should identify the party responsible for implementation, the agency (or agencies) with oversight authority, a recommended schedule for implementation and completion, and the impact, if any, on current or future protectiveness. Please revise the report to provide specific information regarding each of these items, and/or a summary table listing recommendations and follow-up actions**

Response: The final five-year review report will be revised to provide more specific information about the implementation of the recommendation to protect human health through better access controls. The Navy is responsible for implementing and overseeing the necessary protections for IR program sites at NWSSB Detachment Concord, although it may reach agreement with its Army tenant (834th Transportation Battalion) to take action for some of the necessary site controls that overlap with base security requirements. Since some of the access control measures are more security vs. risk reduction, and vice versa, the Navy needs to assess the most time and cost-efficient means to accomplish the recommended access control actions. For instance, some fencing, sign postings, or patrols may be funded as security measures vs. environmental restoration

efforts. Depending on the funding method, the schedule for each may vary. Therefore, per the EPA's comment, the Navy proposes to prepare and include a summary table in the final five-year review report that addresses the plan for the various control measures recommended in Section 10.3.1.1 and 10.3.1.2.

8. Comment: **<u>Land Use Controls</u>: The Navy should include in the supplemental feasibility study report an evaluation of institutional controls necessary to protect human health and the environment during implementation of any additional response actions and thereafter.**

Response: The Navy will consider the use of institutional controls during the FS process. The Navy will also ensure that the implementation of any remedial actions or removal actions will have proper site controls and safety measures for ensuring worker and public safety, and compliance with applicable OSHA construction standards.

9. Comment: **U.S. EPA understands that the Navy's general position is that offsite (non-Navy) contamination which may be mobilized represents a threat to Litigation Areas RASS 1 and 3 that are currently contaminated. Given this position, a similar threat also exists for RASS Area 2 (Navy remedy currently protective) where cleanup action has not been completed at the adjacent Atchison Topeka Santa Fe Railway Remedial Action Area. As a result, the Navy should continue monitoring of this site property to ensure that contaminants remaining in place are not mobilized prior to or during the remaining response actions at RASS 2.**

Response: The Navy is not responsible for contamination resulting from the existing open pits on the Atchison Topeka Santa Fe (ATSF) property in RASS 2. The Navy will review the status of this incomplete remediation during the file review to be conducted during the data gaps evaluation and will convey the results to the regulatory agencies. Evidence of *significant* sources at the ATSF property would affect both the design of the monitoring program and the implementation of any future remedial actions.

10. Comment: **In Sections 10.3.1 through 10.3.3, regulatory agency staff and natural resource trustees should be included as authorized personnel allowed to enter the Litigation Area.**

Response: The report will be revised to include regulatory and trustee agency personnel as authorized to enter the Litigation Area; however, it will also be noted that access to all personnel is dependent on permission from the Navy and that all visitors must be screened and obtain visitor passes at the NWS SBD Concord Badge and Pass office before accessing the sites.

RESPONSES TO RWQCB COMMENTS

A. GENERAL COMMENTS

1. **Comment:** **A major crucial component missing from the final edition of the report pertains to how the Navy proposes to reduce risks to the environment for areas where passive remediation has been recommended in the RAP/ ROD.**

   Response: The Navy is planning to conduct supplemental FSs in three areas (Units 7, 11, and 13) as described in responses to EPA Comments # 2 and # 3. The remaining parts of the Litigation Area, including other areas identified as passive remediation areas in the Remedial Action Plan / Record of Decision (RAP/ROD) where contamination remains in place, will be the subject of limited and focused monitoring. The report will be revised to clarify this issue.

2. **Comment:** **It is unfortunate that the transparent overlays of the hotspots data from Table 65 were not included in the final version. Board Staff recommends their inclusion to enable risk footprints comparisons for aquatic invertebrates (Figure 93) and the avian/ rodents vertebrates (Figure 94).**

   Response: The Navy will not re-issue the figures or provide new figures in the final version of the five-year review report; however, these large-scale overlays can be provided for viewing at meetings.

3. **Comment:** **It is unknown to Board Staff why the Navy believes one round of groundwater sampling is sufficient to characterize metals contamination in groundwater at the litigation area site. Furthermore, it is the Navy's position that contaminants migration would take decades to centuries to reach Suisun Bay (Appendix E, p E-60). Unfortunately, this statement is not yet supported by scientific data collected spatially throughout the litigation area. For example, lithology and stratigraphy is probably heterogeneous at the site. It is likely that sand lenses could offer preferential pathways for contaminants migration to the Bay via groundwater baseflow.**

   Response: As explained in Appendix E, Section 7.2.1 "On-site Groundwater Monitoring", the Navy has sampled each of the Litigation Area wells between 16 and 19 times during four separate sampling episodes since 1987, and proposes to collect additional samples in the future. The next groundwater monitoring event, as described in the SAP submitted to the agencies on March 28, 2003, is scheduled for August 2003. Future

groundwater monitoring will be discussed with the agencies during the development of a new focused monitoring plan.

Lithology of the Litigation Area is briefly summarized in Appendix E, and a more detailed discussion is included in the technical memorandum describing one of the four monitoring events (TtEMI 1997). The Navy agrees that lithology is heterogeneous across the Litigation Area, but disagrees that there is any evidence that lithology is heterogeneous in the RASS 1 marsh or that lithologic heterogeneity will offer preferential groundwater flow pathways that will allow contaminants to migrate to the Bay. A sand lens is present in the area along the railroad tracks as noted in Appendix E, Section 7.3. This lens is oriented parallel to the railroad tracks and to the shoreline of Suisun Bay. Wells located in the marsh, including wells 1MG01, 1AG02, 1AG03, 1AG04, 1PG05, 1PG18, 2MG07, 2AG08, 2AG09, and 3AG10 form a continuous line between the Bay and the sand lens. The lithology of these wells consists of silty clay, and no sandy or permeable intervals were detected in these wells. The Navy acknowledges that it is conceivable that an additional sand lens that is oriented perpendicular to the shoreline could exist and could convey groundwater contamination to the Bay without intersecting any of the monitoring wells or affecting the potentiometric surface, but believes that this possibility is remote.

4. Comment: **Generally, Board Staff might agree that monitoring of groundwater, surface water, soils, sediments and species of special concerns might be reduced especially as it applies to sites processes characterization. However, Board Staff does not agree annual monitoring can be discontinued especially as it applies to areas of specific concerns. Board Staff is in the opinion that surface and ground waters should be monitored on an annual basis for areas where contaminant concentrations are found above State and Federal criteria. Additionally, the Navy should insure accretion processes in the sloughs and channels/ditches are occurring to entomb contaminated sediments horizons. Hence, Board Staff recommends the Navy to propose a monitoring program aimed at documenting recoveries of critical areas to insure the remedies effectiveness. Furthermore, this monitoring effort will help decision-making and the prevention of any additional impairment of Human Health and the Environment.**

Response: Please see response to EPA Comment # 4 that discusses the Navy's proposed approach to future monitoring.

5. Comment: **Board Staff still recommends an in depth analysis of contaminant migration in the litigation area especially as it applies to in situ processes within the sloughs and the ditches.**

Response: The Navy has already conducted a variety of studies focused on analysis of contaminant migration in the sloughs and ditches; these analyses were summarized in Appendix E of the five-year review report. The Navy measured vertical profiles of metals in sediments at 21 locations in the ditches and 10 locations in the slough, compared water quality of incoming and outgoing tides, assessed turbidity throughout the slough, evaluated erosion and scouring in the mosquito ditches, conducted water quality sampling during storm events, and evaluated tidal influence on groundwater. In addition, the RWQCB sampled water quality on incoming and outgoing tides on October 20, 2000, as summarized in Table 24 of the report. The Navy does not believe that additional studies are needed to provide a more in-depth assessment of contaminant migration; rather some limited periodic monitoring of areas where contaminant migration is of concern may be warranted and will be discussed with the agencies during development of a revised monitoring plan.

6. **Comment:** **The regulatory agencies discussed with the Navy the need to evaluate the biotic value of the wetland habitat provided by the litigation area. This recommendation was not presented in the final version of the report.**

Response: The Navy does not plan to conduct an assessment of the biotic value of the wetland. During discussions with the agencies, no agreement was reached on the objectives or potential interpretation of results of an evaluation of biotic value. As already discussed in the report, the FSs that will be conducted to evaluate remedial alternatives for Units 7, 11, and 13 will include an evaluation of the tradeoffs between reduction of chemical risks and the habitat destruction associated with each remedial alternative that includes construction activity.

B. SPECIFIC COMMENTS

1. **Comment:** **<u>Section 4.2.2, Remedial Action Subsite 3, p 4-5</u>: The Navy needs to identify the concentrations of extractable TPH, BTEX and PAHs detected in the site's soils. It is unclear to Board Staff under which program the petroleum contaminated soils will be addressed. It is also unknown if groundwater has been impacted by this contamination.**

Response: The report will not be revised to include details on concentrations of petroleum-related chemicals detected in previous investigations as that is beyond the scope of the five-year review; the objective of this section of the report was to provide background on the remedial action completed at RASS 3. The Navy is willing to discuss with the RWQCB the results from those prior investigations, which are briefly summarized here. During the RASS 3 hydrocarbon investigation, a total of 56 samples were

collected from 13 soil borings at intervals of 3 to 5 feet to the depth of the water table (between 10 and 26 feet below ground surface). These soil samples were collected near the former Getty Oil facility and were analyzed for total petroleum hydrocarbons (TPH) -extractables, TPH-purgeables, benzene, toluene, ethylbenzene, and xylene. Seven soil samples were also analyzed for volatile organic compounds (VOCs). Analysis of the soil samples revealed TPH-extractables as motor oil (up to 8,900 milligrams per kilogram [mg/kg]) and diesel (4,200 mg/kg), TPH-purgeables as gasoline (up to 2,800 mg/kg), and small amounts of benzene (up to 0.2 mg/kg), toluene (up to 0.2 mg/kg), ethylbenzene (up to 4.4 mg/kg), and total xylenes (up to 13.0 mg/kg). Based on the vertical and lateral extent soil contamination, the Navy determined that the likely source was historic spills or pipeline leaks and that there were not significant pathways for exposure or transport of petroleum related products (PRC Environmental Management, Inc. 1993).

The monitoring wells in the Litigation Area were sampled for VOCs and semivolatile organic compounds (SVOC) on two occasions in 1989; BTEX and PAHs were not detected in any sample. In October, 1996 eleven wells, including three wells near the former Getty Oil facility, were sampled for VOCs, SVOCs, and TPH. No VOCs, SVOCs, or purgeable hydrocarbons were detected, but extractable range hydrocarbons were detected in 10 of the 11 samples. The chromatograms for seven of these samples did not exhibit the characteristic spectrum of many peaks that would result from hydrocarbon fuels; instead, these samples exhibited individual peaks or several peaks that were quantified as hydrocarbons at concentrations up to 0.1 milligrams per liter (mg/L) and were flagged with a qualifier to indicate that they were not a fuel. The sample from well 3MG12, was quantified with 0.2 mg/L of motor oil, but was flagged to indicate that the sample chromatogram did not match diesel fuel or motor oil. Samples from wells 1AG04 and 1 PG18 had chromatograms that matched those expected for motor oil at concentrations of 0.1 to 0.4 mg/L. These wells are located well into the marsh and may represent naturally occurring hydrocarbons that are generated in marshes. It is unlikely that they represent contamination from the Getty Oil facility because they are located more than 1000 feet from the former facility and because dissolved hydrocarbon fuels were not reported in wells that lie between the Getty Oil facility and wells 1AG04 and 1 PG18. Complete analytical results for groundwater sampling conducted in the Litigation Area to date are presented in Appendix A of the post-remediation groundwater sampling technical memorandum (TtEMI 1997).

2. **Comment:** **<u>Section 10.2.1, Distressed Vegetation Area in RASS 1, p 10-4</u>: Board Staff recommends reporting for dissolved and total concentrations of metals in groundwater. Additionally, Board Staff advises sampling for surface water (if present) at locations where groundwater and soils samples will be taken. This matrix should be analyzed for the same chemicals of concern, to provide a thorough understanding of contaminant partitioning at discrete locations.**

Response: Grab groundwater samples will be collected by digging holes to the depth of the water table in the wetland and sampling the groundwater that fills in the hole; the proposed methodology is provided in the draft SAP (TtEMI 2003a). The process of installing open borings into unconsolidated silty clay sediments will stir up considerable amounts of clay and silt-sized particles that contain metals as part of their crystal structures. These particles are not mobile under undisturbed conditions. Collecting and analyzing unfiltered samples of the turbid, muddy water that will collect in the open boreholes will not provide meaningful information regarding metals contamination in groundwater because the water will contain both the metals that are mobile and metals associated with the particles, which are not mobile. Accordingly, the samples will be filtered in the field to exclude the immobile particulate fraction of the samples. In addition, it is not likely that sufficient volume of water will be available in the holes to allow collection of both filtered and unfiltered samples.

These grab groundwater samples will be collected when the surface is not inundated by high tide or rainfall, in order to avoid the problem of surface water flowing into the open boreholes. For this reason, grab groundwater samples will not be collected if surface water is present or other means will be employed to exclude surface water from the grab groundwater sampling location. Surface water coming in on the high tide is not considered relevant to the objective of this investigation, which is to evaluate the possibility of contaminated groundwater leaching under the berm separating the Navy property from the General Chemical facility.

3. **Comment:** **<u>Section 10.2.3, Litigation Area Groundwater Sampling, p 10-6</u>: Board Staff advises reporting dissolved and total metal concentrations at the site. It is also unknown to Board Staff what the Navy considers "elevated metals concentrations."**

Response: The objective of groundwater sampling for metals is to assess the fraction of metals that are mobile in groundwater. As discussed above in response to RWQCB specific comment # 2, metals are contained in both particulate and dissolved phases in groundwater. Traditional bailing and purging groundwater-sampling techniques draw silt and clay sized particles into the well where they eventually become incorporated in samples. These particles are not normally mobile in groundwater; therefore, unfiltered

samples typically overestimate the metals concentrations in groundwater. This is of particular concern in the Litigation Area where the wells are all screened in silty clay. Silt and clay sized particles are normally excluded from samples for analysis by field filtering groundwater samples with an in-line 0.45 micron filter. However, filtering samples can exclude the fraction of metals that are present as macromolecules larger than 0.45 microns. EPA has developed a low flow-rate sampling technique that includes the macromolecules that are normally mobile in groundwater and can transport metals, but excludes silt and clay sized particles that are not mobile and cannot transport metals. The Navy intends to use this low-flow rate sampling technique to collect unfiltered groundwater samples from the Litigation Area monitoring wells. Because it is not necessary to assess the fraction of metals transport associated with macromolecules that would be excluded by filtering, filtered samples will not be collected.

As described in the DQOs in the draft SAP (TtEMI 2003a), the Navy plans to compare new groundwater sampling results to those collected during the post-remediation groundwater monitoring event in 1996 to determine if metals concentrations are increasing. Concentrations significantly elevated above previously measured concentrations will be of concern; the statistical comparisons to be conducted are described in the SAP.

4. Comment: **Section 10.2.4, RASS 3 Polychlorinated Biphenyls, p 10-7: The Navy needs to report how the erosional areas will be addressed. Two locations are of concern to Board Staff: Nichols Creek banks and the incompletely remediated areas owned by the ATSF railroad (RASS 2).**

Response: The properties mentioned in the comment are not Navy property and will not be addressed by the Navy. The Navy will revise the report to clarify that the Navy will be conducting a file review to determine if the neighboring railroad companies completed the requirements of the consent decrees and will be assessing the significance of these sources.

5. Comment: **Section 10.2.5, RASS 4 Semi-Lithified Soil Sampling, p 10-8: The Navy needs to indicate if DDT will be included as a pesticide analyte as recommended by Board Staff.**

Response: The three surface soil samples proposed for the area of semi-lithified soil in RASS 4 will be analyzed for the standard suite of pesticides, including dichlorodiphenyltrichloroethane (DDT), as described in the SAP submitted on March 28, 2003 (TtEMI 2003a).

6. Comment: **Section 10.3.1, Recommendation to Protect Human Health, p 10-8: The Navy needs to specify the time frame when these recommendations (such as signage, fencing, access controls, patrols)**

will be implemented. The monitoring frequency of the effectiveness of these measures should be indicated.

Response: Please see response to EPA Comment # 7.

7. Comment: **<u>Appendix D, Section 2.0, Sediment and Soil Chemistry, p D-10</u>: The Navy should define the following ecotoxicological indices: ER-L, ER-M (Effects-Range low/ medium), WCC-c/nc (wetland creation criteria for cover and non-cover). The Navy needs to present how a specific chemical referenced index was derived and compared to site specific data collected. Finally, the rationale why the ER and WC indices were chosen instead of other promulgated State and Federal criteria should be clarified.**

Response: The ER-L, ER-M, and WCC-nc are defined in Appendix D, p D-10 as well as in Appendix G. These are well-established benchmark values that are commonly used as screening values in ecological risk assessments at Navy installations, as well as in investigations at other sites around San Francisco Bay. Details of the derivation of these indices are provided in the references cited in the five-year report; the Navy will not be revising the appendices of the report for the final version.

The ER-L and ER-M were selected as screening benchmarks because of their long-standing usage in sediment investigations and their development by NOAA. The Wetlands Creation Criteria were used for selenium, as there are no NOAA effects-range based values for this chemical. The Navy is not aware of any other state or federal criteria promulgated for wetland sediments.

8. Comment: **<u>Appendix D, Section 3.0, Surface Water Chemistry, p D-24</u>: It is unknown to Board Staff why the value of 400 mg/L was chosen as the calcium carbonate hardness value for the adjustment of the Ambient Water Quality Criteria when the mean hardness value for the litigation area was found at 544 mg/L (Appendix G, Section 5.3.2.1, p G-85).**

Response: The final rule for the California Water Quality Standards, as published in Title 40 Code of Federal Regulations (CFR) Part 131, states in the notes to table 4 of paragraph (c)(2), for waters with a hardness over 400 mg/L as calcium carbonate, a maximum value of 400 mg/L should be used to derive conversion factors for chemicals requiring hardness correction. The hardness conversion was therefore "capped" at 400 mg/L even though hardness values at the site are often higher; this approach was discussed with and agreed to by former RWQBC project manager, Ms. Claudia Villacorta.

9. **Comment:** **<u>Appendix E, Section 4.1.1, Long-term Turbidity Monitoring (January through April 1999), p E-22</u>: It is important to recognize that TSS (Total Suspended Solids) and turbidity data when collected concurrently from incoming and outgoing tides yielded unexpected results. The field data indicates that weakly turbid outgoing tides have higher TSS values than the incoming tides. The Navy advanced the hypothesis that outgoing tides contain high concentrations of organic materials with different light refraction indices than the particles found in the incoming tide. This hypothesis needs to be scientifically tested as organic materials are crucial vectors in contaminant transport and immobilization.**

Response: The Navy recognizes the apparent contradiction between the turbidity measurements and the total suspended solids (TSS) measurements on incoming and outgoing tides, and discussed this apparent incongruity in Section 4.1.1 of Appendix E. The Navy noted that the suspended materials in incoming tides scattered light to a greater extent than suspended materials in outgoing tides. Light scattering is primarily caused by reflection and absorption, not refraction. The Navy suggested that the Litigation Area marsh imports inorganic suspended solids that accumulate on the marsh surface and exports organic suspended solids that scatter light to a lesser extent. Sampling at the mouth of the slough during incoming and outgoing tides by both the Navy and RWQCB did not show high concentrations of metals on outgoing tides and does not support the concept that the organic materials in the outgoing tides mobilize contaminants out of the marsh.

10. **Comment:** **<u>Appendix E, Section 7.5, Litigation Area Groundwater Conclusions, p E-60</u>: The finding that motor oil-range hydrocarbons were detected in almost all of the monitoring wells is interesting. The Navy seems to be of the opinion that the compounds "might be naturally occurring marsh hydrocarbons." Has the Navy compared the chromatograms with a weathered hydrocarbons library?**

Response: Please see response to RWQCB Specific Comment # 1.

11. **Comment:** **<u>Appendix G, Section 5.3.3.5, Bioavailability, Bioaccumulation, and Toxicity of Mercury, p G-96</u>: The Navy could improve its discussion on methyl mercury generation and cycling in the litigation area. For example, it is unknown to Board Staff if at the detected sulfide concentrations, sulfur reducing bacteria are operating to methylate mercury at the litigation area. The Navy needs to refine its analysis by reporting the types of mercuric compounds detected in sediments at the litigation area and their relationship to sulfides concentrations, pH and oxygen reduction potential.**

Response: At the time the mercury samples were collected, mercury was not considered a chemical of potential concern (COPC) at the Litigation Area and analyses for all sediment samples were based on total metals. The Navy does not have data on chemical speciation of mercury and, therefore, cannot refine its analysis to report the relative fraction of mercury that may be present as methyl mercury. Biomagnification of methylated mecury up the food chain would be the pathway of ecological concern at the site. The potential risk from mercury was evaluated using food chain models based on total mercury concentrations (which can be assumed to be higher than the fraction that is methylated); this analysis did not indicate significant risk from mercury. Therefore, the Navy does not believe that further investigation of methylmercury is warranted.

C. EDITORIAL COMMENTS

1. **Comment:** **Appendices D through G: It would be helpful if the reporting dates, author(s), program information were included on the cover pages of each appendix.**

   Response: The format of the report is the approved style for reporting under TtEMI's Navy contracts. The Navy will not be issuing new versions of the appendices; the final version of the five-year periodic review assessment report will include only replacement pages for the main body of the report.

2. **Comment:** **Tables 13 and 14: The spelling of the element Selenium needs to be modified following IUPAC nomenclature conventions.**

   Response: The Navy acknowledges and apologizes for the typographical error in the spelling of selenium in Tables 13 and 14; however, the Navy will not be issuing new versions of the tables, as the final version of the five-year periodic review assessment report will include only replacement pages for the main body of the report.

RESPONSES TO NOAA COMMENTS

Comment: **The National Oceanic and Atmospheric Administration (NOAA) appreciates the opportunity to comment on the Draft Final Five-Year Periodic Review Assessment, Litigation Area Naval Weapons Station Seal Beach, Detachment Concord, Concord, California. The document was prepared for the Navy by Tetra Tech EM Inc., and is dated October 23, 2002.**

NOAA finds the Draft Final document to be well-written, and agrees with the Navy's conclusion that the remedy, as implemented in certain subsites of the Litigation Area, was not effective in protecting ecological receptors from site-related contaminants. Monitoring has

demonstrated that the sediments and surface water in sloughs and ditches located in Units 7, 10, and 11 in Remedial Action Subsite (RASS) 1, and Nichols Creek in RASS 3, remain contaminated at levels that pose a risk to aquatic invertebrates and fish.

NOAA also agrees with the Navy on the following points: 1) Data gaps were identified as a result of monitoring; 2) Additional investigations should be conducted to address the data gaps; 3) Three supplemental feasibility studies are proposed to address deficiencies in the remedy; and 4) Adjacent railroad and chemical companies may be an on-going source of contamination to Navy property.

The Navy has stated that annual monitoring in the RASS areas will be discontinued and the suggested investigations and feasibility studies will not be implemented until off-site sources of contamination are addressed. Although the Navy has stated the intent to work with the Department of Justice and the other companies to address the off-site, on-going contamination of Navy property, the Navy should continue the annual monitoring of the RASS areas and should move forward to determine what type of remedial actions are necessary to address the failed remedy. As part of the remedy for the Litigation Area, contamination was left in place, and long-term monitoring was implemented to see if a natural reduction would occur. In some areas deposition is occurring, and in other areas scouring is exposing more contamination. Annual monitoring is necessary as long as contamination remains on-site at levels that will impact trust resources. Monitoring data will also provide information for the Navy to evaluate the potential impact of uncontrolled releases of contamination migrating onto Navy property from other sources.

The Navy has suggested modifying the existing monitoring approach to provide more focused objectives and data collection, and to link the monitoring to risk reduction. NOAA agrees that some adaptations to the existing monitoring plan may be warranted and a discussion should take place between the Navy, regulatory agencies, and trustees to focus on the most appropriate modifications.

NOAA encourages the Navy to move forward with further evaluation of areas where the remedy failed, and to continue annual monitoring. NOAA is willing to work with the Navy to revisit the monitoring plan and to provide input into focusing future data collection.

Response: The Navy appreciates NOAA's comments on the report and the willingness of NOAA to work with the Navy on developing future monitoring plans. Please see responses to EPA Comments # 2, 3, 4, 5, and 9 for specific information on how the Navy plans to address concerns raised by NOAA in regards to protecting trustee resources, assessing

offsite sources, future monitoring, and supplemental feasibility studies to evaluate potential remedial actions.

RESPONSES TO DTSC COMMENTS

1. **Comment:** **The Draft Final document is well-written. The Navy concludes that in certain sub-areas within the Litigation Area the remedy was not effective in protecting ecological receptors from site-related contaminants. The Navy conducted extensive monitoring and has demonstrated that the sediments and surface water in sloughs and ditches located in Units 7, 10, and 11 in Remedial Action Subsite (RASS) 1, and Nichols Creek in RASS 3 remain contaminated at levels that pose a risk to aquatic invertebrates and fish. There continues to be a risk to birds and mammals from zinc and selenium associated with the main reach of Lost Slough (Units 9 and 10), the western arm of Lost Slough (Unit 11), and the ditches in Units 5 and 7.**

   Response: Comment acknowledged.

2. **Comment:** **Based on the monitoring conducted by the Navy, several data gaps were identified and the Navy has proposed three supplemental feasibility studies to address the identified deficiencies in the remedy. HERD is in agreement with this finding and the proposed supplemental studies.**

   Response: Comment acknowledged; please see responses to EPA comments # 2 and 3.

3. **Comment:** **The results of the monitoring program have indicated that there are continuing, non-Navy sources of contamination entering the Litigation Area. The Navy suspects that the adjacent railroad and chemical companies may be the source of contamination to Navy property. The Navy has stated the intent to work with the United States Department of Justice and the other companies to address the off-site, on-going contamination of Navy property. HERD agrees that there may be non-Navy sources of contamination entering the Litigation Area and supports efforts to control the on-going releases.**

   Response: Please see responses to EPA comments # 2 and 9.

4. **Comment:** **The Navy has stated that annual monitoring in the RASS areas will be discontinued and the suggested investigations and feasibility studies will not be implemented until off-site sources of contamination are addressed. The Record of Decision allowed some contaminants to be left in place to see if natural attenuation would address the contaminant levels. Monitoring has indicated that this remedy may**

have failed based on the results of toxicity bioassays, bioaccumulation testing, and exceedances of sediment benchmarks. The Navy should continue the annual monitoring program because contaminants left in place have not attenuated, and the wetlands are a sensitive habitat with threatened and endangered species present. Annual monitoring will provide the Navy with information to evaluate the extent of the impact from the potential, off-site sources, as well as determine if additional remedial actions are likely to be effective. HERD supports the Navy's stated intent to work with the U.S. Department of Justice and the other companies to address the off-site, on-going contamination of Navy property. However, regardless of the activities of adjacent property owners, as long as contamination remains on-site at levels that will impact ecological receptors, the Navy should continue the annual monitoring of the RASS areas. In addition, HERD recommends that the Navy conduct the proposed supplemental feasibility studies to determine the type of remedial actions necessary to address the sub-areas where the remedy has failed.

Response: Please see responses to EPA comments # 2 and 4 and RWQCB comment # 1.

5. **Comment:** **The Navy has suggested modifying the existing monitoring approach to provide more focused objectives and data collection, and to link the monitoring to risk reduction. HERD agrees that some adaptations to the existing monitoring plan may be warranted and a discussion should take place between the Navy, regulatory agencies, and the natural resource trustees to focus on the most appropriate modifications.**

Response: Please see response to EPA comment # 4.

6. **Comment:** **<u>Conclusion</u>: HERD agrees with the Navy's conclusion that the remedy has not been effective in certain units of the Litigation Area. HERD also agrees that supplemental studies are necessary to fill data gaps and to determine whether additional remedial actions are warranted. HERD strongly recommends that the Navy continue the annual monitoring of the Litigation Area, and supports a review and possible modification of the monitoring plan strategy.**

Response: Please see responses to EPA comments # 2, 4, and 5.

REFERENCES CITED

PRC Environmental Management, Inc (PRC). 1993. RASS 3 Hydrocarbon Site Investigation, Summary Report. Draft. November 4.

Tetra Tech EM Inc (TtEMI). 1997. "Technical Memorandum: Tidal Influence Study and Post-remediation Groundwater Monitoring, Naval Weapons Station Concord." July 22.

TtEMI. 2003a. Draft Sampling and Analysis Plan (Field Sampling Plan/Quality Assurance Project Plan), Data Gaps Evaluation for the Litigation Area, Naval Weapons Station Seal Beach Detachment Concord. March 28.

TtEMI. 2003b. Area of Concern 1 (Site 31) Draft Time-Critical Removal Action Close-out Report, Naval Weapons Station Seal Beach, Detachment Concord. March 10.