



**FINAL
REMEDIAL ACTION PLAN
RECORD OF DECISION
RCRA CLOSURE PLAN
INVESTIGATION AREA H1
Mare Island, Vallejo, California**

Prepared for
**DEPARTMENT OF TOXIC
SUBSTANCES CONTROL**
Berkeley, California

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LIST OF ACRONYMS

§	Section
95UCL	95 percent Upper Confidence Limit
AM	Action Memorandum
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BAAQMD	Bay Area Air Quality Management District
bgs	below ground surface
BRAC	Base Realignment and Closure Act
BTEX	benzene, toluene, ethylbenzene, and xylenes
Cal. Code Regs.	California Code of Regulations
Cal. Fish & Game Code	California Fish & Game Code
CAMU	Corrective Action Management Unit
CCL	Compacted Clay Layer
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/s	centimeters per second
COC	Chemical of Concern
COEC	Chemical of Ecological Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CPT	Cone Penetrometer Testing
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DDD	Dichlorodiphenyldichloroethane
DDT	Dichlorodiphenyltrichloroethane

LIST OF ACRONYMS

DOD	United States Department of Defense
DON	United States Department of the Navy
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
DWBZ	Deep Water-Bearing Zone
E&E	Ecology and Environment, Inc.
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
°F	degrees Fahrenheit
FOST	Finding of Suitability to Transfer
FS	Feasibility Study
GCL	Geosynthetic Clay Liner
gpm	gallons per minute
HDPE	High-Density Polyethylene
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HW	Hazardous Waste
IA-H1	Investigation Area H1
IPOC	Interim Point of Compliance
IR	Installation Restoration
IRAP	Interim Remedial Action Plan
IRP	Installation Restoration Program
IT	International Technology Corporation
IW	Industrial Wastewater
IWBZ	Intermediate-Water Bearing Zone

LIST OF ACRONYMS

IWTP	Industrial Wastewater Treatment Plant
LS	length and steepness
LSA	LSA Associates, Inc.
MBTA	Migratory Bird Treaty Act
MCE	Maximum Credible Earthquake
MCFR	Marine Corps Firing Range
MCL	Maximum Contaminant Level
MEC	Munitions or Explosives of Concern
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MINS	Mare Island Naval Shipyard
mm	millimeter
MOU	Memorandum of Understanding
mph	miles per hour
NAD	Naval Ammunition Depot
NCP	National Contingency Plan
NMOC	Non-Methane Organic Compound
NPDES	National Pollution Discharge Elimination System
O&M	Operations and Maintenance
ORNL RAIS	Oak Ridge National Laboratory On-Line Risk Assessment Information System
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyl
POTW	Publicly Owned Treatment Works
PRC	PRC Environmental Management, Inc.
PRG	Preliminary Remediation Goal

LIST OF ACRONYMS

RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Site Inspection
SSTP	Sanitary Sewage Treatment Plant
SVOC	Semivolatile Organic Compound
SWBZ	Shallow Water-Bearing Zone
TAPP	Technical Assistance for Public Participation
TCRA	Time Critical Removal Action
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
TPH-d	Total Petroleum Hydrocarbons-Diesel
TPH-m	Total Petroleum Hydrocarbons-Motor Oil
TRV	Toxicity Reference Value
TtEMI	Tetra Tech EM, Inc.
USC	United States Code
USFWS	United States Fish and Wildlife Service
USLE	Universal Soil Loss
VOC	Volatile Organic Compound
VSFCD	Vallejo Sanitation and Flood Control District
Water Board	San Francisco Regional Water Quality Control Board
WESTON	Weston Solutions, Inc.

LIST OF ACRONYMS

WMA

Western Magazine Area

WQSAP

Water Quality Sampling and Analysis Plan

1. DECLARATION STATEMENT AND IA-H1 RAP/ROD/RCRA CLOSURE PLAN APPROVAL

1.1 SITE NAME AND LOCATION

Investigation Area H1 (IA-H1) is located at the Mare Island Naval Shipyard (MINS), Mare Island, Vallejo, California. The United States Environmental Protection Agency (EPA) Identification Number for the site is CA7170024775.

1.2 STATEMENT OF BASIS AND PURPOSE

This Remedial Action Plan (RAP)/Record of Decision (ROD)/Resource Conservation and Recovery Act (RCRA) Closure Plan presents the selected remedial action for the IA-H1 at Mare Island, Vallejo, California. This document was developed in accordance with the following regulations:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA)
- Title 42 United States Code (USC) Section (§) 9602 et seq.
- National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Title 40 Code of Federal Regulations (CFR), Part 300 et seq.
- RCRA, Title 40 CFR, Part 360 et seq.
- California Health and Safety Code Chapters 6.5 and 6.8

The decision presented in this document is based on the administrative record files for this site. The state of California (through the California Environmental Protection Agency Department of Toxic Substances Control [DTSC] and the California Environmental Protection Agency San Francisco Regional Water Quality Control Board [Water Board],) has evaluated the selected remedy.

1.3 REMEDIAL ACTION PLAN

This RAP/ROD/RCRA Closure Plan satisfies the DTSC requirements for a RAP for hazardous substance release sites pursuant to California Health and Safety Code § 25356.1.

1.3.1 Assessment of the Site

Actual or threatened releases of hazardous substances from soil and groundwater at IA-H1, if not addressed by implementing the remedial action selected in this RAP/ROD/RCRA Closure Plan, may present a current or potential threat to public health and welfare or to the environment.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The selected remedial action described in this RAP/ROD/RCRA Closure Plan addresses potential risks to human health and the environment posed by the IA-H1.

The remedy was selected from the alternatives presented in the Feasibility Study and include:

Containment Area – Alternative 2A:

Multilayer Variable Cap, Institutional Controls, Groundwater Containment, and Gas Monitoring

Upland Areas – Alternative 4:

Institutional Controls, Hot Spot Removal (Hazard Quotient [HQ]-3), Groundwater Monitoring, and 2-Foot Soil Cover

Non-Tidal Wetland Areas –Alternative 5:

Institutional Controls, Hot Spot Excavation (HQ-1), and Monitoring

The major components of the selected remedy for IA-H1 include the following:

- Construction and maintenance of RCRA hazardous waste and non-RCRA hazardous waste multilayer caps in the Containment Area. The Containment Area includes the area inside the existing groundwater Containment Barrier that Weston Solutions, Inc. (WESTON) constructed in September 2004 as part of the Interim Remedial Action, around the RCRA/Facility Landfill, plus known or suspected areas of contamination that could impact groundwater, and includes a groundwater extraction trench and slurry wall. The Containment Barrier is further defined in Section 2.5.2. The multilayer caps will work in conjunction with the installed slurry wall and groundwater extraction trench to isolate and eliminate direct contact with refuse and reduce soil erosion, infiltration, and potential contaminant migration. Soil gas vents will be included in the RCRA cap and

non-RCRA cap design. Surface controls will include grading and revegetation to reduce soil and erosion. The RCRA hazardous waste cap will cover approximately 32 acres and the non-RCRA hazardous waste cap will cover approximately 40 acres.

- Collection of groundwater from the Containment Area groundwater extraction trench as needed, and proper disposal of the water. The slurry wall prevents off-site lateral migration of contaminated groundwater. Once the caps are installed, the groundwater extraction trench will serve to further reduce the groundwater mounding inside the RCRA/Facility Landfill, thereby further reducing the potential for vertical migration of contaminants.
- Removal of soil and sediment from localized areas containing elevated levels of contaminants (hot spots) in the Upland and Non-Tidal Wetland Areas, with consolidation of the removed material into the Containment Area prior to capping.
- Confirmatory soil sampling upon completion of the hot spot removal to establish that the hot spot areas meet site-specific cleanup goals.
- Development of new non-tidal wetlands as mitigation for the loss of low-grade non-tidal wetlands in the Containment Area and restoration of any non-tidal wetlands disturbed by remedial activity. Wetland creation activities and monitoring will be guided by the requirements set forth in the Biological Opinion issued by the United States Fish and Wildlife Service (USFWS).
- Placement of a 2-foot soil cover on the Upland Areas outside the Containment Area after hot spots have been removed.
- Monitoring within the Non-Tidal Wetland Areas to determine if contaminant levels are changing and/or migrating.
- Groundwater monitoring to determine if contaminants are moving from the Upland Areas to the Non-Tidal Wetland Areas.
- Long-term groundwater monitoring to ensure the effectiveness of the capping systems, slurry wall and groundwater extraction trench in the Containment Area.
- Land use controls to protect the integrity of the Containment Area cap, monitoring wells, upland soil cover and associated piping and equipment. Land use controls are also

necessary to prevent activities that could disturb the cap or expose contaminated media, and limit exposure pathways. Land use controls are applicable to the entire IA-H1 including the wetland creation areas.

- Requirement for a restrictive land use covenant or equivalent mechanism to prohibit sensitive uses, such as schools, hospitals, and residential use, prohibit uses incompatible with the remedy and residual contamination left in place, to maintain various remedial action features such as soil covers, to prohibit soil disturbance and groundwater extraction without approval from DTSC for non-transferred areas of IA-H1.

The CERCLA investigation, evaluation, and planning for IA-H1 have resulted in the selection of the above site-specific remedy with associated land use controls to prevent unacceptable exposure and to protect human health and the environment. The remedy is consistent with the stated future use of this area as recreational/open space.

1.5 STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. The selected remedy uses permanent solutions and satisfies the statutory requirements of CERCLA.

The remedy includes site-specific risk-based removal of contaminant concentrations for the areas outside the Containment Area and application of the presumptive remedy inside the Containment Area. A presumptive remedy is a remedial action that has been applied to similar sites based on previous remedial decisions. The Final Feasibility Study (FS) (WESTON, 2006a) evaluated the waste excavation and off-site disposal in the Containment Area as an alternative and showed that because of the volume and heterogeneity of the waste contents, large scale excavation and disposal was not practical or cost-effective. This confirms the application of the presumptive remedy of containment for the Containment Area.

Because the remedy leaves potentially hazardous substances in place at concentrations above the levels that allow for unlimited use and unrestricted exposure, the United States Department of the Navy (DON) will conduct five-year reviews in accordance with CERCLA Section 121C. The

reviews will ensure that the remedy continues to provide adequate protection of human health and the environment.

1.6 RAP/ROD/RCRA CLOSURE PLAN DATA CERTIFICATION CHECKLIST

The Data Certification Checklist provides a roadmap to the RAP/ROD/RCRA Closure Plan and identifies the location of key elements addressed in the document. Additional information can be found in the administrative record file for this site.

RAP/ROD/RCRA Closure Plan Data Certification Checklist

Checklist Item	Description
1. Chemicals of concern and their respective concentrations.	In accordance with the EPA's presumptive remedy guidance for landfills, chemicals of concern within the Containment Area and their concentrations have not been fully delineated. The containment removes the exposure pathway and the requirement for full delineation. Upland and Non-Tidal Wetland Areas outside the Containment Barrier are discussed in Section 5.1.
2. Baseline risk represented by the chemicals of concern.	For the Containment Area, baseline risk assessment calculations are not required in order to implement the EPA's presumptive remedy (containment). Upland and Non-Tidal Wetland Areas outside the Containment Barrier are discussed in Section 7.
3. Cleanup levels established for chemicals of concern and the basis for these levels.	The EPA's presumptive remedy (containment) eliminates the exposure pathways. Cleanup levels are therefore not included in this RAP/ROD/RCRA Closure Plan. Cleanup levels for the Upland Areas outside the Containment Barrier and Non-Tidal Wetland Areas outside of the Containment Barrier are based on the risk assessment and are discussed in Sections 7 and 8.
4. How source materials constituting principal threats are addressed.	Characterization and source materials are discussed in Sections 5, 7, and 8.
5. Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD.	Current and anticipated future land uses at the site are discussed in Section 6.
6. Potential land and groundwater use that will be available at the site as a result of the selected remedy.	Potential land and groundwater use possible at the site as a result of the selected remedy is discussed in Sections 6, 8, and 9.
7. Estimated capital, annual operation and maintenance, regulatory oversight costs and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.	The estimated costs, discount rate, and the number of years over which the remedy and regulatory oversight cost estimates are projected are discussed in Section 12.
8. Key factors that led to selecting the remedy.	Key factors that led to selecting the remedy are discussed in Sections 9 and 10.

Authorizing Signatures and Acceptance of Remedy

As documented by the signature below, the DON has approved the RAP/ROD/RCRA Closure Plan for IA-H1.

For the United States Department of the Navy:

Signature: Michael S. Bloom 8/4/06
Date
Michael S. Bloom
Department of the Navy
Base Realignment and Closure Environmental Coordinator
Mare Island Naval Shipyard
BRAC Program Management Office West

For the State of California Environmental Protection Agency:

The DTSC approves this RAP/ROD/RCRA Closure Plan/RCRA Closure Plan and authorizes implementation of the selected remedy set forth herein. The selected remedy is protective of human health and the environment.

Signature: Anthony J. Landis 8-3-06
Date
Anthony J. Landis, P.E.
Chief, Northern California Operations
Office of Military Facilities
Department of Toxic Substances Control
California Environment Protection Agency

Authorizing Signatures and Acceptance of Remedy

As documented by the signature below, the DON has approved the RAP/ROD/RCRA Closure Plan for IA-H1.

For the United States Department of the Navy:

Signature: _____
Michael S. Bloom
Department of the Navy
Base Realignment and Closure Environmental Coordinator
Mare Island Naval Shipyard
BRAC Program Management Office West
Date _____

For the State of California Environmental Protection Agency:

The DTSC approves this RAP/ROD/RCRA Closure Plan/RCRA Closure Plan and authorizes implementation of the selected remedy set forth herein. The selected remedy is protective of human health and the environment.

Signature: _____
Anthony J. Landis, P.E.
Chief, Northern California Operations
Office of Military Facilities
Department of Toxic Substances Control
California Environment Protection Agency
Date _____

2. DECISION SUMMARY FOR IA-H1

In accordance with the Mare Island Remediation Agreement between the City of Vallejo and Weston Solutions, Inc. (WESTON) and the Environmental Services Cooperative Agreement between the United States Department of the Navy (DON) and the City of Vallejo, WESTON has prepared this Investigation Area H1 (IA-H1) Remedial Action Plan (RAP)/Record of Decision (ROD)/Resource Conservation and Recovery Act (RCRA) Closure Plan of the Mare Island Naval Shipyard (MINS). This document presents the selected remedial action for soil and groundwater at IA-H1, MINS, Vallejo, California. The United States Environmental Protection Agency (EPA) identification number for this site is CA7170024775.

This RAP/ROD/RCRA Closure Plan satisfies the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) requirements for a RAP for hazardous substance release sites pursuant to California Health and Safety Code Section (§) 25356.1, and satisfies the requirements for a RCRA Closure Plan in accordance with the applicable sections of California Health and Safety Code Chapters 6.5 and 6.8. This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and the RCRA requirements. The decision for this site is based on information contained in the administrative record.

2.1 SITE NAME AND LOCATION

This decision document addresses soil and groundwater at IA-H1 at MINS, Vallejo, California. The Mare Island peninsula is located in Solano County, California, approximately 25 miles northeast of San Francisco (Figure 2-1). Mare Island is bordered by San Pablo Bay to the west, Carquinez Strait to the south, and Highway 37 to the north. The Napa River (Mare Island Strait) separates Mare Island from the mainland and the City of Vallejo to the east. The main entrance to Mare Island is a causeway that spans Mare Island Strait, connecting Mare Island to the City of Vallejo at Tennessee Street. A second access is located at the northern end of Mare Island, where

Railroad and Walnut Avenues connect to Highway 37. Mare Island is within the incorporated boundaries of the City of Vallejo.

2.2 LEAD AND SUPPORT AGENCIES

MINS was closed on 1 April 1996 after 142 years of operation, in accordance with the United States Department of Defense (DOD) Base Realignment and Closure (BRAC) Act of 1993. In accordance with the Federal Facilities Site Remediation Agreement dated 15 July 2002 (DTSC, 2002), the Naval Facilities Engineering Command, Engineering Field Activity West was responsible for completing a Remedial Investigation (RI) at the MINS. The site is not on the National Priorities List. The lead agency under CERCLA for the investigation and remedial action at this base is the DON, and the lead agency under RCRA and the California Health and Safety Code Chapters 6.5 and 6.8 is the DTSC, with support from the California Environmental Protection Agency San Francisco Bay Regional Water Quality Control Board (Water Board).

2.3 SITE DESCRIPTION

IA-H1, shown in Figure 2-2, occupies approximately 230 acres within the west central portion of Mare Island. The elevation of IA-H1 varies from 6 feet above mean sea level (amsl) in the wetland and dredge ponds area to 23 feet amsl on the berms. The exception to this elevation range is the RCRA/Facility Landfill, where the top of the land surface is 42 feet amsl. IA-H1 is bounded by dredge ponds to the north, west, and south. IA-H1 is currently isolated from the rest of Mare Island by a locked gate and fencing located at the Dump Road entrance to IA-H1.

This RAP/ROD/RCRA Closure Plan discusses remedial alternatives for IA-H1 in three functional areas: the RCRA/Facility Landfill and adjacent areas inside the existing groundwater Containment Barrier (i.e., the Containment Area), the Upland Areas outside the Containment Barrier (includes all areas outside the Containment Barrier that are not wetlands), and the Non-Tidal Wetland Areas outside the Containment Barrier. Figure 2-3 shows each area. RCRA interim status areas include the RCRA Landfill inside the Containment Area, the Industrial Wastewater Treatment Plant (IWTP) Sludge Treatment/Surface Impoundment Area, and the IWTP pipeline in the Upland Areas, as shown in Figure 2-3.

2.3.1 Geology and Topography

The geology of Mare Island is schematically illustrated in Figure 2-4, which is a block diagram that shows the stratigraphic relationships of the various units described in this section.

The geology of Mare Island can be characterized as an eroded bedrock surface exposed in the southern part of the peninsula. A blanket of unconsolidated Quaternary sediments and artificial fill material overlays the bedrock surface at most other locations. Three principal geologic units have been identified at Mare Island. These include, from top to bottom stratigraphically, artificial fill material, unconsolidated natural deposits, and bedrock. The artificial fill material is a heterogeneous unit consisting of clay, silt, sand, gravel, and debris in varying proportions. The unconsolidated natural deposits consist primarily of a thick sequence of silty clays commonly referred to as “Young Bay Mud” as well as intermediate and lower sand units of the San Antonio Formation. The bedrock consists of sandstone, siltstone, and shale. The Young Bay Mud consists of soft, uniform, gray silty clay containing occasional thin, discontinuous sand lenses and shell fragments.

The Young Bay Mud is generally consolidated, soft, and highly compressible. The upper 4 to 6 feet of the Young Bay Mud has been weathered and desiccated and is often stained black. At greater depths below the desiccated crust, the Young Bay Mud is gray to olive-gray in color and soft, highly plastic, and highly compressible. Silt content may vary with depth. Minor, widely spaced, discontinuous sand seams may also be present. The Young Bay Mud increases in thickness to the west (toward San Pablo Bay) and to the northwest, reflecting a steep topographic drop in the bedrock surface. The unit varies from approximately 5 feet thick on top of the bedrock ridge up to approximately 55 feet thick near the western edge of the island. A Late Pleistocene alluvium (intermediate sand) underlies the Young Bay Mud and ranges in depth from 18 to 30 feet below ground surface (bgs), but is found at depths of up to 50 feet bgs in some areas west and southwest of the RCRA/Facility Landfill. Where present, this unit occurs as a lenticular (lens-shaped) body of gray, predominantly fine to medium-grained sand, and has localized areas that contain lesser amounts of silt and clay.

Underlying the Young Bay Mud is the Old Bay Mud. The Old Bay Mud is an unoxidized stiff to very stiff silty clay that has been preconsolidated to a considerable degree. This lower silty clay unit is variable in color with irregular dimensions, and forms an aquitard between the

intermediate water-bearing zone (IWBZ), where present, and the underlying deep sand. This unit varies in thickness from approximately 3 to 18 feet (where the intermediate sand unit is present). In areas where the intermediate sand pinches out, the upper portion of Old Bay Mud is in direct contact with Young Bay Mud.

The Pleistocene alluvium deposited on top of the bedrock surface consists of a mixture of clay, silt, sand, and fine gravel with a greater proportion of fine-sands and clayey sediments. This lower sand unit, while not encountered in all areas, is inferred to be continuous throughout the site area. This unit is present at depths ranging from approximately 30 to 65 feet bgs.

The San Francisco Bay area is recognized by geologists and seismologists as an active seismic region in the United States. The closest fault is the Rogers Creek–Healdsburg Fault, which is approximately 6 kilometers from IA-H1. The maximum credible earthquake (MCE) is the largest reasonable earthquake that might occur at a nearby fault, and is used in the design of critical structures such as landfills, dams, and emergency control facilities. Based on the magnitude of the MCE and the distance from the site, the peak horizontal rock and ground acceleration at the site can be estimated. The Rodgers Creek fault, using EQFAULT, was identified as the MCE for the site as a magnitude 7 on the Richter Scale with associated slope stability factors for the site.

2.3.2 Hydrology

Three water-bearing zones (shallow, intermediate, and deep) have been identified at Mare Island. The shallow water-bearing zone (SWBZ) refers to both artificial fill and naturally deposited materials intersected by the water table. The IWBZ and deep water-bearing zone (DWBZ) correspond to the intermediate and lower sands, respectively, where separated by silty clay. The high concentration of dissolved solids (i.e. salinity) within groundwater from all three water-bearing zones, and low extraction rates, precludes groundwater from any beneficial uses (Water Board, 2004).

Shallow Water-Bearing Zone

The SWBZ is the most shallow unit in which groundwater is encountered at Mare Island. The upper boundary of the SWBZ is the water table, indicating that this zone is unconfined. This zone is a heterogeneous unit consisting of saturated artificial fill material and the upper portion

of the Young Bay Mud. The lower portion of the Young Bay Mud is apparently a zone of lower hydraulic conductivity separating the SWBZ from the IWBZ. The transition between the bottom of the SWBZ and the top of the zone of lower hydraulic conductivity within the Young Bay Mud is undefined but is likely gradational and variable throughout Mare Island. SWBZ monitoring wells at Mare Island are screened at depths of approximately 20 feet bgs or less, and the screened intervals of these wells generally intersect the water table. Based on groundwater elevations, the direction of groundwater flow in the SWBZ is largely influenced by groundwater mounding in the area of the RCRA/Facility Landfill. Groundwater within the SWBZ flows outward from this mound to the southwest, west, and northwest towards the groundwater extraction trench. Figures 2-5 and 2-6 present the SWBZ groundwater elevation contours (potentiometric surface map) and groundwater flow directions during the wet and dry seasons.

Intermediate Water-Bearing Zone

The Late Pleistocene alluvium comprises the IWBZ, which is present beneath the Young Bay Mud in most areas. The intermediate sand attains a maximum thickness of approximately 15 feet in some areas and appears to pinch out (disappear) to the west of the IA-H1 RCRA/Facility Landfill. Groundwater elevation measurements indicate that groundwater in the IWBZ consistently flows to the west/northwest, as shown in Figures 2-7 and 2-8. The higher groundwater elevations in this area may be the result of pressure head buildup within the unit since it appears to pinch out to the west and/or is the result of excess pore water pressure from the weight of the RCRA/Facility Landfill mass. Static water elevations 20 to 40 feet above the top of the intermediate sand unit were routinely measured during the quarterly sampling events indicating confined or semiconfined conditions resulting from the overlying Young Bay Mud. Additionally, the IWBZ dips away from the original island margin, which leads to increasing depth of burial by less permeable silty clays farther from the original island.

Deep Water-Bearing Zone

The DWBZ consists of the Pleistocene alluvium deposits. The uppermost portion of this lower sand has been visually observed to be a tan, fine to medium-grained silty sand unit encountered at depths of approximately 40 to 65 feet bgs in the vicinity of the RCRA/Facility Landfill. The uppermost portion of the lower sand is more than 40 feet thick in the area west of the RCRA/Facility Landfill, appears to increase in thickness to the west, and gradually dips toward

the west. This uppermost portion of the DWBZ is nearly continuous throughout IA-H1. The deeper portions of the DWBZ consist of sand lenses within a silty clay. The potential for interconnection of the various sand lenses or units is possible; however, it is unknown whether a direct hydraulic connection exists. Monitoring wells have only been installed in the uppermost portion of the DWBZ.

Potentiometric surface maps, constructed from first quarter 2005 and third quarter 2005 water level measurements, indicate that groundwater in the DWBZ flows consistently in a west to northwesterly direction (Figures 2-9 and 2-10). Static groundwater elevations of approximately 45 feet above the top of the lower sand unit were routinely measured during the quarterly sampling events, indicating that groundwater in this zone occurs under confined or semiconfined conditions. Additionally, the DWBZ dips away from the original island margin, which leads to increasing depth of burial by less-permeable silty clays farther from the original island. The primary sources of recharge for this unit are leakage or interconnection with the IWBZ and infiltration at the original island margin. In contrast with the IWBZ, local mounding in the SWBZ potentiometric surface does not influence the potentiometry of the DWBZ. Pumping tests have also shown that the DWBZ is hydraulically connected to the IWBZ (Tetra Tech EM, Inc. [TtEMI], 1999); however, this connection appears to be limited.

2.3.3 Climate

The climate at Mare Island is moderated by the proximity of San Francisco Bay. It is generally warm and dry in the summer and cool and wet in the winter. The daily average air temperature, as recorded at the Mare Island power plant, was 58 degrees Fahrenheit (°F) between 1984 and 1988. Average minimum/maximum temperature ranges were from 49 to 95°F in the summer and 38 to 74°F in the winter during the same time period. Daily average wind speeds measured at the power plant at Mare Island were typically 5 to 10 knots [6 to 12 miles per hour (mph)] from the west. Maximum velocities of 20 to 30 knots (23 to 35 mph) were often recorded, particularly during winter months. Average barometric pressure is 30 inches of mercury. Average annual rainfall at Mare Island, based on daily measurements between 1878 and 1994, was 18.07 inches per year. Measurable precipitation typically occurs 50 to 60 days each year. About 95 percent of the total precipitation occurs between October and April.

2.3.4 Ecology

The major habitat types found at or around Mare Island include intertidal mudflats and open water, tidal wetlands, non-tidal wetlands, actively maintained dredge ponds, and uplands. IA-H1 consists of upland habitat and non-tidal wetland habitat referred to as Wetlands A, B, C, D, and X in this document (Figure 2-3). The tidal wetland habitat lies to the west of IA HI. The offshore habitats at Mare Island are located to the east and south in the Mare Island Strait and Carquinez Strait. A special status plant (defined by statutory threatened or endangered species and other lists) survey was performed at the project area and found that no special status species are present on the site and that habitat for these species is absent. (LSA, 2006a)

2.3.4.1 Upland Habitat

Upland habitats are well-drained areas above the effects of tidal action. Uplands at Mare Island consist of grasslands and shrublands. Most of the undeveloped area of IA-H1 consists of upland habitat. On Mare Island, these areas are mostly highly disturbed grasslands that have little native vegetation remaining along the boundary of non-tidal wetlands and active dredge ponds.

Most of the landscaped areas of Mare Island do not provide substantial habitat. The upland habitat is largely composed of fill material covered with shrubs and grasses. Coastal prairie and scrub communities dominate drier areas of the upland habitat. Both native and exotic plants are present in the upland habitat. Plant species most important to wildlife include lupines, coyote brush, and rabbit brush.

Little information about upland habitat invertebrates is available for Mare Island. Terrestrial invertebrates using the tidal wetlands are likely to also use the adjacent uplands. The terrestrial invertebrates of the upland habitat probably consist of arachnids and insects. Large soil invertebrates, such as earthworms, most likely live in these areas because the soils are poorly drained and moist. Reptile species include the western fence lizard (*Sceloporus occidentalis*), southern alligator lizard (*Gerrhonotus multicarinatus*), northern alligator lizard (*Gerrhonotus coeruleus*), coast horned lizard (*Phrynosoma coronatu*), common kingsnake (*Lampropeltis getulus*), gopher snake, ringneck snake (*Diadophis punctatus*), racer (*Coluber constrictor*), rubber boa (*Charina bottae*), western rattlesnake (*Crotalus viridis*), coast garter snake, and sharp-tailed snake (*Contia tenuis*). The western rattlesnake has been known to nest on the south

side of the island (Lemmon and Wichels, 1977) and likely feeds upon small mammals and amphibians in adjacent upper marsh areas. Amphibian species likely to occur in the upland habitat include the aboreal salamander (*Aneides lugubris*), California slender salamander (*Batrachoseps attenuatus*), western skink, Pacific treefrog, California newt (*Taricha torosa*), and western toad (TtEMI, 2002).

Many of the bird species found in the wetland habitats also forage in the adjacent upland habitat. Predominant bird species include the California quail, red-tailed hawk (wintering), great blue heron, northern harrier, white-tailed kite, American kestrel, merlin, mourning dove, and brewer's blackbird. Common upland habitat mammals include shrews, California ground squirrels, California voles, and jackrabbits.

Large mammal species include coyote, black-tail deer, and gray fox. Bat surveys conducted in 1994 detected the Mexican free-tailed bat (*Tadarida brasiliensis*); bats are not likely to occur in high numbers on Mare Island because of the paucity of native vegetation and lack of tree cover (Constantine and Tetra Tech, Inc., 1994).

2.3.4.2 Non-Tidal Wetland Habitat

Manmade non-tidal wetlands and upland areas were created at Mare Island from tidal wetlands as a result of dredging activities. Beginning in 1935, the DON actively diked and filled the tidal wetlands on the northern and west central portions of Mare Island with Mare Island Strait dredged sediments. The non-tidal wetlands are subject to temporary inundation during wet periods. IA-H1 has five non-tidal wetlands (Wetlands A, B, C, D, and X). Some of these are shallow depressions characterized by standing water during the winter and spring and are dry during the summer and fall.

Non-tidal wetlands support a variety of plants, invertebrates, amphibians, birds, and small mammals. Vegetation in non-tidal wetlands varies greatly and is highly dependent on ponded water depth and salinity. Pickleweed rapidly colonizes, and it can tolerate high sediment salinities during the dry season emergence. Sedges and rushes often cover seasonally flooded areas. The dominant invertebrate taxa typically present in the wetlands include species of the *Corixidae*, *Chironomidae*, *Hydrophilidae*, and *Ephydriidae* families. Few benthic invertebrates

are found because of the seasonal drydown and non-tidal nature of these wetlands. Amphibians that may be present in non-tidal wetlands include the western toad, Pacific tree frog, red-legged frog, bullfrog, northern leopard frog, and western pond turtle. Reptiles such as snakes may be present in the non-tidal wetland habitats but are more common in the drier, hotter upland habitat. Non-tidal wetland areas provide important habitat for migratory shorebirds and resident water birds. They are home to many birds found in tidal wetlands, including ducks (canvasback, mallard) and shorebirds (California least tern, marbled godwits, avocets, and long-billed curlew). Small mammals, such as the salt marsh harvest mouse and Suisun shrew are present in the non-tidal wetlands. Portions of non-tidal wetlands, which are dominated with pickleweed, provide primary habitat for the salt marsh harvest mouse, which is listed as an endangered species by both state and federal governmental agencies.

2.4 SITE HISTORY AND INVESTIGATION ACTIVITIES

This section provides an overview of the history of IA-H1 and summarizes the investigation activities that have taken place at the site.

2.4.1 Site History

The following discussion on the historical development of Mare Island is based on information presented in a historical survey of the shipyard (Mighetto and Youngmeister, 1986) and an archeological resources inventory (Archeological Resource Service, 1986), unless noted otherwise.

MINS was the first naval station established on the Pacific Coast. The DON purchased 956 acres of Mare Island in 1853 and commenced shipbuilding operations on 16 September 1854. The subsections that follow describe the development of the infrastructure of Mare Island and the primary historical land uses and activities. These activities included shipbuilding, ship repair, dredge and fill activities, manufacture and storage of munitions, and waste disposal.

2.4.2 Infrastructure

Mare Island was originally a true island off the shore of Vallejo, accessible only by boat. Ferries transported shipyard workers and supplies. The first crossing, constructed in 1919, was a wooden causeway with a drawbridge that connected Mare Island (at A Street) to Vallejo (at Tennessee Street). The existing concrete causeway (also with a drawbridge) that connects to Mare Island at G Street, replaced this crossing in 1935. In the late 19th century, roadways on the island were unpaved. Horses and carts were used to transport raw materials from the docks to the shops and finished products back to the ships. By the early 20th century, roads were paved, and railroad tracks were installed. When the concrete causeway was completed in 1935 with a railroad track to the mainland, trains became the primary mode of transportation for both workers and supplies.

When shipyard operations first began, every tool shop on the base had its own source of heat and power. As the facilities expanded, the need for centralized power increased. Consequently, in 1918 the DON constructed a steam-driven power plant (Building 121) to supply the shipyard with both steam (for heat and industrial processes) and electrical power. In the late 1930s, an overhead auxiliary power connection was established.

When the shipyard was being constructed during the latter half of the 19th century, fresh water was not plentiful on Mare Island. The DON first established a reservoir in the hills on the southern portion of the island and constructed a variety of cisterns near the housing and industrial areas for storing water necessary for drinking and fighting fires. Some cisterns are still present in the historical portions of the MINS. In 1898, a pipeline was installed from Vallejo to deliver fresh water. The reservoir was then used primarily for fire protection in the ordnance manufacturing and storage areas. In 1928, when the first pump was installed in Building 121, a saltwater distribution system began delivering saltwater for fire protection and various shipyard needs (Metcalf and Eddy, Inc., 1976). Additional pumps and piping were later installed to carry saltwater to the fire fighting training school within IA-H1, the ordnance manufacturing and storage areas, and other locations across Mare Island.

The storm water collection system originally carried storm water runoff, sanitary sewage, and industrial wastewater (IW) to outfalls along Mare Island Strait. In the late 1950s, a sanitary sewer system was built to divert the sanitary wastes to a new Sanitary Sewage Treatment Plant

(SSTP) located in the western portion of Mare Island at the western end of Dump Road within IA-H1. Treated effluent from the plant was discharged into San Pablo Bay. New sewers were also installed in the 1950s to separate storm water and sanitary wastes, preventing combined overflows to the strait. An IW collection system pipeline and the IWTP were constructed in 1972, adjacent to the SSTP within IA-H1. The IW collection system connected to industrial shops across Mare Island. Treated effluent was discharged into San Pablo Bay until 1976, when that practice was prohibited. The treated effluent was then routed to the City of Vallejo wastewater treatment plant. Wastewater process units included primary sedimentation, chemical treatment, and tertiary treatment. Primary treatment removed oil, floatable material, and settleable sludges in the Primary Sedimentation Tank; chemical treatment removed hexavalent chromium, heavy metals, and emulsified oil; and tertiary treatment improved the effluent water quality prior to discharge. Chemical treatment processes performed at the IWTP included the use of lime (calcium hydroxide), sulfur dioxide, sulfuric acid, and polyelectrolytes (anionic and cationic polymers). Chlorine was used in a final treatment step. Prior to the MINS closure in 1996, the DON reportedly flushed and emptied process piping and equipment. The IWTP aboveground structures were removed in 2002 by WESTON. The belowground components of the IWTP located within the Containment Area were abandoned in place in 2004 in conjunction with the installation of the Containment Barrier.

The IWTP and pipeline within the limits of IA-H1 are RCRA-regulated units. The steel pipeline in IA-H1 was strapped to an adjacent concrete pipe constructed on pilings. This ensured that this stretch of piping was much less likely to leak than other areas of the pipe that were not supported. Sample results near the pipeline do not indicate that there were any pipeline leaks or spills, and any contamination is consistent with the surrounding soils. The pipeline was inspected and flushed in November 2005. No breaks in the pipeline were observed, and analysis of the rinsate did not indicate any residual contamination within the pipeline (WESTON, 2006b). Closure of the IWTP pipe will be accomplished through implementation of the CERCLA remedies in the areas of IA-H1 that include the pipe run.

2.4.3 Ship Construction and Maintenance Activities

The primary ship construction and maintenance area of the MINS was established along the northeast shore of the original island, adjacent to Mare Island Strait. Initially, this area was roughly bounded by A Street on the north, 11th Street on the south, and Railroad Avenue on the west. The shipyard area then expanded to cover an area roughly bounded by G Street to the north, Railroad Avenue to the west, and the Building 900 area to the south. A number of brick buildings constructed in the late 19th century are still present in the original shipyard area; this area has been designated a historic district. The entire shipyard area has undergone vast transformations during years of operation as shipbuilding technologies advanced from wooden to steel construction and from wind power to nuclear propulsion. With these changes, the variety and amount of industrial chemicals and oils used in construction and maintenance activities increased.

The first permanent dry dock on the Pacific Coast was completed at Mare Island in 1891. Prior to its construction, a floating dry dock was used. A second dry dock was completed in 1910. After these two structures were completed, wooden wharves were replaced with concrete and steel quay walls supporting railroad track, effectively extending the shipyard boundary further into Mare Island Strait. Dry Docks 3 and 4 were constructed in the 1930s and 1940s, respectively. Early in the development of the shipyard, the DON began testing experimental submarines at Mare Island. In 1904, a submarine wharf was constructed just south of Dry Dock 2. Because of its success with test craft, the DON established a base for submarine construction and maintenance on reclaimed land north of the wooden causeway (today between A and G Streets) in the early 1920s. The first submarine built at Mare Island was launched in 1930. As the submarine repair base expanded, other development related to the base took place in this area. Specifically, a petroleum storage and refueling area with aboveground and underground storage tanks was established alongside the quay wall at Berth 4, and maintenance and repair shops for the lead-acid submarine batteries were constructed east of the fuel storage area (Buildings 461, 463, and 463A).

In 1923, an airfield was constructed northwest of the submarine base immediately north of A Street on the west side of California Street, but it was no longer in use by 1924. The airfield was

officially deactivated in 1937. After the concrete causeway was completed in 1935, additional shipbuilding ways were established just north of the causeway for small craft construction. Housing, warehouses, a paint manufacturing facility, and additional docks were also built in this area. Near the end of the 1930s, the workers in the shipyard began using radium paints for manufacturing equipment with luminescent dials and displays. Low-level radioactive materials were generally confined to the buildings in which they were used; however, handling procedures were not regulated at the time. In later years, storage and handling of low-level radioactive materials were strictly controlled.

During World War II, MINS reached peak capacity for shipbuilding, repair, overhaul, and maintenance. More than 40,000 workers were employed and 390 new ships (including landing craft, destroyers, and submarines) were built during this era. In addition, 1,207 ships of all types, including cruisers and submarines, were repaired and overhauled.

After the war, Mare Island was considered one of the primary stations for construction and maintenance of the DON's Pacific fleet of submarines. Decreasing needs in the postwar environment; however, resulted in decreased shipyard activity. In particular, activity north of G Street declined and, as a result, housing in the area was removed; shipbuilding ways were no longer used; and docks were constructed for mooring of reserve (inactive) vessels. The paint manufacturing facility was closed in the mid-1950s and only the warehouses remained in use. The shipyard was then modified to allow construction of nuclear-powered submarines as well as storage and handling of nuclear materials. The first nuclear-powered submarine constructed at Mare Island (the *USS Sargo*) was launched in 1957. Seventeen nuclear-powered submarines were constructed over the course of operations at the MINS.

2.4.4 Dredge and Fill Activities

Starting in the late 19th century, frequent dredging of the waterfront adjacent to Mare Island was required to maintain shipping lanes. At that time, the Sacramento River carried large quantities of silt that had been eroded by large-scale hydraulic mining activities in the Sierra Nevada. A portion of this material traveled downstream and was deposited in San Pablo Bay. In the absence of major streams or sloughs on the western side of Mare Island, sediment settled out of the water and tended to accumulate along the western shoreline.

In 1908, Dike 12 was constructed on the southern end of the island to reduce the amount of sediment in San Pablo Bay that could be flushed back into the Mare Island Strait with the tide. As a result, sediment accretion along the western shoreline of Mare Island increased and the island mudflat areas expanded. By the late 1930s, most of the western shore of Mare Island had become a mudflat as a result of sedimentation caused by the presence of Dike 12. Beginning in the late 1930s, slurry from dredging operations in Mare Island Strait was intermittently pumped across Mare Island into two large berm-bounded impoundments (commonly referred to as dredge ponds). After allowing the solids to settle for a few days or weeks, the clarified water from the ponds was discharged to the western tidal marsh and San Pablo Bay through a series of weirs and ditches. A large volume of dredge materials has accumulated as a result of this process. Large areas of land were reclaimed by filling ponds to the north, west, and south of the shipyard with materials from frequent dredging in the shipping channel and pier areas of Mare Island Strait. Over time, a number of additional dredge ponds were formed by creating new berms within and outside of the existing ponds as well as by extending the network of pipes and outfalls. As the ponds reached capacity, new berms were constructed further west to form new dredge ponds. IA-H1 is composed of large areas of land that were reclaimed with spoils from frequent dredging in the ship channel and pier areas. Figure 2-11 shows how the historic dredge and fill disposal areas formed at Mare Island and gives a timeframe for when the dredge ponds were created.

The DON constructed levees in the mudflat areas along the western shoreline to hold dredge material pumped from Mare Island Strait. Currently, there are seven dredge ponds capable of receiving dredge material pumped from Mare Island Strait: six along the western shore (Ponds 4N, 4M, 4S, 2N, 2M, and 2S) and one at the southern end of Mare Island (Pond 7) as shown on Figure 2-2. Five filled, inactive dredge ponds (Ponds 1, 3N, 3E, 3W, and 5N) are also located northwest of IA-H1 as shown in Figure 2-2.

The region north of the original island (north of A Street), where the submarine repair base was built, was an area of tule marshes. Much of the land between A and G Streets was filled with materials excavated during early construction activities in the original shipyard. These activities included dry dock excavation and land grading in the area referred to as Dublin Hill, near the northern end of the original island. Filling with dredge material and other materials from shipyard activities primarily reclaimed the land further north of G Street.

2.4.5 Manufacture and Storage of Munitions

Since 1936, ordnance was manufactured and stored at the southern end of Mare Island, away from the shipyard and residential areas. By 1857, the DON had constructed the first ammunition magazine, and soon thereafter, a loading wharf was completed. Later development included additional magazines, ordnance-production facilities, and ordnance-handling piers. The area was upgraded to a Naval Ammunition Depot (NAD) in 1936. In 1957, NAD operations merged with the Naval Magazine Port Chicago, located across the Carquinez Strait at Bay Point, near the City of Concord. The consolidated installation was named “Naval Weapons Station Concord.” As a result, the area of munitions storage and maintenance operations at Mare Island was commonly referred to as the “Concord Annex.”

A pond (Pond 7S) was constructed to hold materials dredged from around the ordnance-loading piers at the southern shoreline of the Concord Annex area near Dike 12. The dredge pond was eventually filled and a second dredge pond (Pond 7) was established. During the years of ordnance production, certain fill areas near Dike 12 and the historical dredge pond were used for burning and burying ordnance and ordnance production waste. This area was included in the Installation Restoration (IR) program as Site IR05.

In 1973, ordnance production activities in Concord Annex ended. Many key production buildings, magazines, and warehouses were subsequently used to store general, inert materials. Some were converted for use as office space, such as the United States Coast Guard station at the southeastern tip of the Concord Annex.

Records describing the disposal of ordnance material at specific landfill sites could not be located. Several live 20 millimeter (mm) and 40 mm anti-aircraft projectiles were recovered in 1993 from a location along the eastern edge of Wetland X. Subsequent visual surface sweeps of Wetland X revealed additional ordnance related material including smokeless propellant containers and what appeared to be burned ordnance slag. All ordnance-related material found to date in IA-H1 was located inside the Containment Area. No ordnance materials have been documented in the Upland or Non-Tidal Wetland Areas.

2.4.6 Waste Disposal Practices

The following is an overview of the most significant disposal activities. From 1910 to 1930, construction debris and solid waste were disposed of outside IA-H1 on the east side of the intersection of Azuar Drive (formerly Cedar Avenue) and A Street. From 1925 to 1942, construction debris and solid waste were disposed of outside IA-H1 north of Dump Road and west of Cedar Avenue.

From 1942 to 1966, dumping occurred in the undeveloped areas of IA-H1, including portions of the RCRA/Facility Landfill, Northwest Dump Road Subarea, West Subarea, Solid Waste Disposal/Lead Oxide Storage Subarea, and Sludge Treatment/Surface Impoundment Subarea. This was referred to as “historical disposal.” Figure 2-13 depicts historical phases of these disposal activities in IA-H1. Types and volumes of waste received at the Historical Disposal Areas were not documented, but the wastes are assumed to consist primarily of shipyard construction debris and municipal wastes, some of which are suspected to contain hazardous wastes. Hazardous wastes may have included spent sandblast abrasives, waste paints, solvents, acids, caustics, plating bath wastes, mercury wastes, forklift and submarine batteries, waste oil, sludge, grease, polychlorinated biphenyl (PCB)-contaminated fluids and clothing, pesticide containers, scrap metal and wood, infectious wastes from the dispensary, radium-containing equipment, and asbestos (Ecology and Environment, Inc. [E&E], 1983).

By the mid-1960s, levees were constructed at Mare Island to define a waste disposal area south of Dump Road and west of the oil sumps along Dump Road. The 30-acre disposal area, referred to as the “Facility Landfill,” was used to dispose of most shipyard wastes. The Facility Landfill reached capacity in 1978, and a new landfill was established on top of the western half of the filled area. This new landfill (referred to as the “RCRA Landfill” because it operated under RCRA interim status) was prohibited from accepting hazardous wastes with the exception of asbestos-containing materials, solvent-laden rags, paint sludge, and spent sandblast abrasives. Hazardous wastes prohibited from the RCRA Landfill were disposed of off-site. The RCRA Landfill was closed in 1989; thereafter, all solid wastes were disposed of off-site. The RCRA/Facility Landfill location is illustrated in Figure 2-3, and it is estimated to contain 600,000 tons of refuse, at a maximum thickness of 42 feet in certain places.

Free product has been observed near the groundwater table in borings and test pits within the Waste Disposal Sump (IR02)/Lead Oxide Storage and Disposal Area (IR16 Subareas B1/B2). Waste oil was discharged to unlined oil sumps constructed within IA-H1 in the late 1930s and early 1940s. These sumps reportedly received approximately 4.5 million gallons of waste oil and solvents before disposal ended in the late 1960s (E&E, 1983). An unknown but likely considerable volume of the waste oil discharged to the sumps was reclaimed. A former Mare Island DON employee (Mr. Toby Lemmon) was contacted by WESTON and confirmed that a DON contractor recovered oil from the sumps. Mr. Lemmon worked at MINS from 1941 until he retired in 1973. He recalled that from the time he began working in 1941, oil was being discharged into the area now known as the IR02 Oily Waste Disposal Area. The discharge point was located near the south side of Dump Road. From the discharge point, it appeared that the oil spread throughout the IR02 area. Most of the discharge consisted of bilge (oil and salt water mixture), which was removed from the ships in the docks. This practice continued until approximately 1966. Sometime during the early to mid 1960s, a reclamation contractor was contracted to reclaim the oil. Mr. Lemmon does not recall the name of the company, but it was a local company from Suisun City, Fairfield, or Sacramento, and he recalls them to be on site removing the oil for as long as 18 months. He recalled that the contractor used heaters and separators to reclaim the oil. It was during this timeframe that the oil sumps were being backfilled (Lemmon, 2006).

2.5 SUMMARY OF REMEDIAL INVESTIGATION ACTIVITIES

The purpose of the remedial program is to identify, investigate, assess, characterize, and clean or control releases of hazardous substances as well as to reduce the risk to human health and the environment from past waste disposal operations and hazardous material spills in a cost effective manner. The program is administered in accordance with the following laws:

- CERCLA, as amended by SARA
- RCRA
- California Health and Safety Code Chapters 6.5 and 6.8

The following sections describe investigations, studies, and removal actions at IA-H1.

2.5.1 Remedial Investigations

RI activities for sites within IA-H1 were first reported in the draft RI reports for Operable Units (OUs) 2 and 3 (PRC Environmental Management, Inc. [PRC], 1997; PRC, 1996). A Revised Preliminary Draft RI Report for IA-H1 included only the sites within IA-H1 (TtEMI, 2000). The primary purpose of TtEMI's RI was to detail the nature and extent of any contamination and, as appropriate, to conduct a baseline risk assessment and to evaluate whether available data were adequate to perform site feasibility studies (FSs).

The May 2000 TtEMI RI for IA-H1 was part of the DON's Installation Restoration Program (IRP) for Mare Island. A March 1983 Initial Assessment Study (E&E, 1983) and Phase I of the RI (International Technology Corporation [IT], 1992) were previously conducted under the IRP. Based on the results of the IT Phase I RI and several site-specific studies with similar objectives, 24 IR sites were eventually identified on Mare Island for inclusion in the Phase II RI.

The 24 IR sites were also referred to as the Group I sites. Sites identified through the preliminary assessment (PA) and site inspection (SI) screening process are considered Group II sites. Other sites of potential concern, identified through a fenceline-to-fenceline review of the base conducted by the DON, regulatory agencies, and the Restoration Advisory Board (RAB), are referred to as Group III sites. The RI for Group I through III sites was conducted concurrently with base closure activities at Mare Island.

To ensure that reuse priorities were considered in determining the focus and schedule for environmental cleanup efforts, the DON, in consultation with the regulatory agencies, divided the installation into IAs. These IAs were intended to generally coincide with the reuse zone boundaries identified in the City of Vallejo's Mare Island Final Reuse Plan (City of Vallejo, California, 1994). The May 2000 TtEMI RI focused on areas within IA-H1. These areas are shown in Figure 2-12 and include Group I IR sites IR01 (Undeveloped Area), IR02, IR06, IR14, IR16 B1/B2, IR16 B3/B5, IR24 and one Group II/III site, the SSTP overflow pond.

WESTON revised the TtEMI Draft RI report and submitted two separate Draft RIs for soil and groundwater of IA-H1. The Draft Final Groundwater RI report was dated May 2002 (WESTON, 2002a). The Draft Soil RI, dated September 2002, included IA-H1, IR05, and the WMA

(WESTON, 2002b). Based on comments received from regulatory agencies for these two RIs, WESTON developed a Data Gaps Sampling Plan (WESTON, 2003a) to implement additional soil borings, groundwater sampling, and cone penetrometer testing (CPT) to complete additional contaminant nature and extent determination and further soil and geologic/hydrogeologic characterization. At the direction of DTSC, the groundwater and soil RIs were combined, and the results of the data gaps sampling were then incorporated into the combined soil/groundwater Draft Final RI for IA-H1 (WESTON, 2004b), submitted in July 2004. A Final RI for IA-H1 was submitted in July 2005 (WESTON, 2005a). A summary of the results of the most recent RI is presented in Sections 5 and 7.

2.5.2 Interim Remedial Action

WESTON prepared a Final Action Memorandum/Interim Remedial Action Plan (AM/IRAP) to document the DON's decision to undertake a Time Critical Removal Action (TCRA) within IA-H1 (WESTON, 2004a). The IA-H1 AM/IRAP involved constructing a slurry wall and a groundwater collection trench around a portion of the perimeter of the RCRA/Facility Landfill and adjacent disposal sites. The Final AM/IRAP was signed and approved by the DTSC and the DON in March 2004 and the work completed in September 2004. The Containment Area enclosed by the Containment Barrier and collection trench occupies approximately 72 acres. It consists of several subareas of IA-H1 as shown in Figure 2-12, including the RCRA/Facility Landfill and portions of IR14, the Sludge Treatment/Surface Impoundment Area (IR02), the Waste Sump/Lead Oxide Storage and Disposal Area (IR02 and IR16 Subareas B1/B2), the Solid Waste Disposal/Lead Oxide Storage and Disposal Area (IR16 Subareas B3/B5), and other areas adjoining the RCRA/Facility Landfill (the Northwest Dump Road Subarea, and the West Subarea). Figure 2-14 shows a typical cross-section of the Containment Barrier.

The Containment Barrier surrounds at least three potential sources of groundwater contamination in IA-H1: the RCRA/Facility Landfill, the IWTP surface impoundments, and the oil sumps. The interim action was designed to essentially eliminate the lateral migration of hazardous substances and contaminants of concern. As part of the IRAP preparation activities, contaminated soil within IR16 Subareas B3/B5 was excavated and staged inside the Containment Area to allow

construction of extracted groundwater and compressed air conveyance piping and an operations building to house the air compressor, an oil/water separator, and sampling equipment.

Also in 2005, a Time Critical Removal Action performed by the Navy at the Mare Island Marine Corps Firing Range produced 37,270 cubic yards of material that was similarly or less contaminated than the materials already in the IA-H1 Containment Area. This material was stockpiled in the Containment Area pending a final decision on the remedy for IA-H1. This stockpiled and/or similar material from Mare Island is proposed to be used to provide a base upon which to build a RCRA or non-RCRA hazardous waste cap.

2.5.3 Feasibility Study

The Draft FS for IA-H1 was issued in November 2004 (WESTON, 2004c), the Draft Final FS for IA-H1 was issued in November 2005 (WESTON, 2005b), and the Final FS for IA-H1 was issued in May 2006 (revised in July 2006) (WESTON, 2006a). The FS developed and evaluated alternatives for each of the three areas of IA-H1 (the Containment Area, the Upland Areas, and the Non-Tidal Wetland Areas). A summary of the FS alternatives is presented in Sections 8 and 9.

3. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The United States Department of the Navy (DON) developed a Community Relations Plan to document concerns identified during community interviews and to provide a detailed description of community relations activities planned in response to information received from the community. The most current Final Community Relations Plan is dated 23 August 2001 (DON, 2001).

The community relations program includes specific activities for obtaining community input and keeping the community informed. These activities include conducting interviews, holding public meetings, issuing fact sheets to provide updates on current cleanup activities, maintaining an information repository where the public can access technical documents and program information, disseminating information to local and regional media, and making presentations to local groups. Information repositories are maintained by the DON, the California Environmental Protection Agency, and at the John F. Kennedy Library at 505 Santa Clara Street in Vallejo, California for easy access by the public.

3.1 RESTORATION ADVISORY BOARD

The RAB for Mare Island was formed in 1994 to review and discuss current and projected environmental investigation activities at Mare Island. Meetings of the RAB include updates on field activities, funding issues, and other technical and administrative matters. RAB meetings are open to the public and are attended by the DON, California Environmental Protection Agency Department of Toxic Substances Control (DTSC) and San Francisco Bay Regional Water Quality Control Board (Water Board) personnel, city and county health and environmental officials, and interested members of the community. By sharing information during regularly scheduled meetings with the groups they represent, RAB members help increase awareness and progress of the site cleanup process. In addition, members of the public can contact RAB members to obtain information or express concerns to be discussed at subsequent meetings.

The RAB currently meets monthly to discuss project progress, review reports, and comment on investigation and cleanup activities. The RAB also reviews and provides comments on

documents for Installation Restoration (IR) sites, such as Preliminary Assessment (PA), Site Inspection (SI), Remedial Investigation (RI), and Feasibility Study (FS) reports, risk assessments, work plans, engineering evaluation/cost analyses, decision documents, and site closure reports. The DON funded a Technical Assistance for Public Participation (TAPP) grant for the Mare Island RAB to provide for an independent review of the Investigation Area H1 (IA-H1) Draft and Draft Final RI reports. Results from this review were discussed with the RAB and comments forwarded to WESTON and the DON for consideration and/or incorporation. Information regarding site restoration and RAB activities are available online at <http://www.mareisland.org>.

The remedial alternatives proposed in the IA-H1 Draft FS were discussed at a RAB meeting in January 2005. An independent review of the Draft FS, funded through a second TAPP grant for the RAB, was conducted in early 2005, and the results were discussed at the April 2005 RAB meeting. A RAB focus group meeting regarding the Draft Final FS was held with the community on October 4, 2005. This was a working community focus group to discuss site issues and gather community input for the Draft Final FS. The Draft Final FS was issued in October 2005 and the Final Feasibility Study and Final Draft RAP/ROD/RCRA Closure Plan issued in May 2006 and revised and finalized in July 2006. A Public Meeting to discuss the remedy presented in the Final Draft RAP/ROD/RCRA Closure Plan was held on June 1, 2006. The transcript of the public meeting is included as Appendix C. A public comment period ran from June 1 to June 30, 2006. A responsiveness summary is included as Appendix D.

4. SCOPE AND ROLE OF REMEDIAL ACTION

Remedial actions presented in this Remedial Action Plan (RAP)/Record of Decision (ROD)/Resource Conservation and Recovery Act (RCRA) Closure Plan were selected based on United States Environmental Protection Agency (EPA) guidance for remedial alternatives analysis (EPA, 1988; EPA, 1991a). The scope of remedial actions at Investigation Area H1 (IA-H1) is as follows:

Containment Area — Multilayer cap placement; groundwater containment using a slurry wall and groundwater extraction trench; landfill gas venting and monitoring; mitigation for loss of wetlands; and institutional controls, including exclusion of the public from the Containment Area.

Upland Areas — Removal of soil in locations contaminated above the site-specific remediation goals (hot spots); groundwater monitoring; a 2-foot soil cover; and institutional controls.

Non-Tidal Wetland Areas — Removal of soil in locations contaminated above the site-specific remediation goals (hot spots); wetland monitoring; and institutional controls.

Also included are institutional controls for the site, including a restrictive land use covenant (or equivalent agreement for portions of IA-H1 for which a restrictive land use covenant cannot be implemented) to prohibit sensitive uses, to maintain various remedial action features such as soil covers, and to prohibit soil disturbance and groundwater extraction without approval from the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) and an operations, maintenance, and long term monitoring plan (including an equivalent RCRA Post Closure Monitoring Plan). These remedial actions are protective of human health and the environment, comply with federal and state regulations, and are cost-effective.

5. SUMMARY OF SITE CHARACTERISTICS

5.1 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the extent of contamination at Investigation Area H1 (IA-H1) and the risks to human health and the environment using information from the Final Remedial Investigation (RI) (Weston Solutions, Inc. [WESTON], 2005a).

5.1.1 Groundwater

Groundwater at IA-H1 has been monitored for various naturally occurring compounds and contaminants since 1987. In the Final RI, the database of contaminant concentrations was compared to the screening levels, which were the ambient/background metal concentrations for metal constituents and California Environmental Protection Agency San Francisco Bay Regional Water Quality Control Board (Water Board) screening criteria from the Screening for Environment Concerns at Sites with Contaminated Soil and Groundwater, (Regional Water Quality Control Board [Water Board, 2005]).

Based on the heterogeneous nature of the material within the Containment Area, and the presence of free product, the extent of contamination in the shallow water-bearing zone (SWBZ) inside the Containment Area is defined to include all of the groundwater underneath the Containment Area. The Final RI (WESTON, 2005a) concluded that the following chemical constituents detected over the years that monitoring was performed exceeded the screening criteria in the SWBZ inside the Containment Area: metals, dioxins/furans, explosives, organotins, polychlorinated biphenyls (PCBs), pesticides, semivolatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and volatile organic compounds (VOCs).

Outside the Containment Area, 24 metals, cyanide, dioxins/furans, pesticides, SVOCs, TPH, and VOCs were the historically detected constituents that exceeded the screening criteria in the SWBZ. The extent of arsenic, manganese, nickel, and zinc were found to include the entire IA-H1 SWBZ. In the latest four rounds of sampling, TPH as diesel (TPH-d) and TPH as motor oil (TPH-m) were the only organic contaminants detected above the screening criteria. Cyanide was

detected only once at a low concentration over the many years monitoring performed. The presence of TPH-d and TPH-m is consistent with the site use history.

According to the Final FS (WESTON, 2006a), the extent of lead and zinc contamination includes the entire intermediate water-bearing zone (IWBZ) within IA-H1. Various other constituents are limited to smaller areas within the IWBZ, including antimony, copper, lead, manganese, mercury, molybdenum, tributyltin, TPH-d, and nickel. The extent of metal contamination in the IWBZ is assumed to be associated with natural processes. A total of seven occurrences of metals exceeding the screening criteria were observed in the IWBZ during the four Resource Conservation and Recovery Act (RCRA)/Facility Landfill groundwater monitoring events that occurred in 2005 (WESTON, 2005c; WESTON, 2005d).

The extent of aluminum, cadmium, lead, and zinc contamination includes the entire deep water-bearing zone (DWBZ) within IA-H1. Various other constituents are limited to smaller areas within the DWBZ, including copper, manganese, mercury, and molybdenum (WESTON, 2006a). The extent of contamination in the DWBZ is assumed to be associated with natural processes.

Gross alpha, gross beta, radium 226, and radium 228 were detected in a majority of samples from the SWBZ inside and outside of the Containment Barrier, and in all samples from the IWBZ and DWBZ inside and outside the Containment Barrier. The detected concentrations thus far are considered to be consistent with naturally occurring radioactivity and radionuclides for this area.

5.1.2 Soil

Containment Area

Within the RCRA Landfill, disposed waste was segregated into three cells (construction debris, solvent-contaminated materials, and asbestos). Similar materials, along with municipal solid waste refuse, were disposed of within the former Facility Landfill footprint, a portion of which underlies the RCRA Landfill. The remaining portions of the Containment Area received waste oil in several oil sumps and construction debris, discarded equipment, and miscellaneous waste in a random manner. Spent sand-blast grit (green sand) was also deposited on the surface within this area. Lead-contaminated soil from the former Lead Oxide Storage and Disposal Area (IR16

Subareas B3/B5) was consolidated within the Containment Area during the Interim Remedial Action described in Section 2.5.2.

The Final RI (WESTON, 2005a) did not attempt to fully characterize the RCRA/Facility Landfill content because of its heterogeneous nature and because the presumptive remedy for landfills, i.e., containment, would be the most likely remedy.

The detection of VOCs and SVOCs in surface and subsurface soil in the Non-RCRA Area at concentrations that exceed the screening criteria is very rare. Benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), naphthalenes, and 1,4-dichlorobenzene were found to exceed the screening criteria (Water Board, 2005) in a few samples collected from the Non-RCRA Area. These compounds are components of petroleum products, and their occurrence in the surface and subsurface soil is consistent with the presence of oil sumps and other sources of petroleum products in the Non-RCRA Area. Concentrations of 1,4-dichlorobenzene, cis-1,2-dichloroethene, tetrachloroethylene, and trichloroethylene exceeded the screening criteria in one sample each for the Non-RCRA Area. These are volatile industrial chemicals that undergo natural attenuation through biodegradation and volatilization in surface and subsurface soil.

Based on limited sampling data (10 soil gas borings), it has been observed that landfill gas is being generated primarily within the RCRA Landfill portion of the Containment Area, and little is being generated within the remainder of the Containment Area (WESTON, 2005a). The non-methane organic compounds (NMOCs) identified during soil gas sampling and analysis at IA-H1 fall into three major groups: halogenated solvents, petroleum fuel constituents, and ketones (including alcohols and oxygen-containing compounds). The presence of these classes of chemicals is consistent with the subsurface materials at IA-H1, such as solvent-laden rags and waste petroleum products. Levels of NMOCs typically produced at a municipal landfill are 0.01 to 0.6 percent, according to the Agency for Toxic Substances and Disease Registry (ATSDR), *Landfill Gas Primer, An Overview for Environmental Health Professionals* (ATSDR, 2001); in the RCRA-regulated units, the NMOC levels were 0.0092 percent, and outside the RCRA-regulated units, the NMOC levels were 0.000025 percent. Methane gas production within the RCRA Landfill is consistent with methane production at a typical municipal landfill. Methane

production in a typical municipal landfill ranges from 45 to 60 percent. Methane in the RCRA-regulated units ranged from 25 to 38 percent, and levels outside the RCRA-regulated units ranged from 0.0064 to 2.9 percent. The results and differences in soil gas generation from the RCRA-regulated units to the remainder of the Containment Area will be considered in the design document to appropriately design gas collection, venting, and monitoring. Gas generation will be included in the monitoring program once the remedy is applied. These results will be verified after implementation of the remedy.

Chemical contamination in the Non-RCRA Area is predominantly associated with gasoline, diesel fuel, waste oil, metals, and Aroclor-1260. The occurrence of petroleum products and volatile and semivolatile constituents is very limited in the Non-RCRA Area; chlorinated solvents and industrial chemicals were found in one sample each. Pesticides, which very rarely exceed the screening criteria in the surface and subsurface soil, occur mostly in wetland sediment where they pose a threat to the environment.

Upland Areas outside the Containment Barrier

The Upland Areas consist of many subareas with a layer of fill material under the surface soil. The fill often includes concrete, wood, asphalt, paper, rubber, rebar, pipes, and glass, and is highly heterogeneous with no identifying point sources. The fill is likely the source of much of the Upland Areas contamination. Metals were identified above screening criteria in all of the subareas, but concentrations generally decrease with depth, except for chromium. PCBs, pesticides, SVOCs, and TPH were frequently identified above screening criteria in each subarea, but were limited to a few sampling locations (hot spots).

Non-Tidal Wetland Areas outside the Containment Barrier

Most of the areas within the Non-Tidal Wetland Areas are former dredge ponds, containing mostly dredge material overlying Young Bay Mud. The sources of contamination in these areas are likely the dredge material and stormwater runoff from adjacent contaminated areas, such as the Demolition Debris Subarea, Fire-Fighting Training Subarea, Defense Reutilization and Marketing Office, and Waste Sump Areas. Metals detected above screening criteria in the Non-Tidal Wetland Areas were often confined to the sediment, with the exception of chromium, which was found above screening criteria in underlying soils. Pesticide, PCB, SVOC, and TPH

contamination was often limited to a few points in each of the subareas within or directly adjacent to the fill areas within the Upland Areas.

5.2 CONTAMINANT FATE AND TRANSPORT

5.2.1 Containment Area

Surface erosion by wind or water, volatilization from the subsurface materials to air, and the downward migration of contaminants with rainwater infiltration are all considered potential migration pathways for soil contaminant migration within the Containment Area. Shallow soil particles with adsorbed contaminants may be eroded by wind or rainfall, suspended and transported in air or surface water runoff, and redeposited either on or off site. Infiltrating precipitation may serve as a pathway for soluble soil contaminants to migrate to the groundwater. The VOCs detected in soil may adsorb to soil, biodegrade, volatilize, migrate through the vadose zone, and, in the absence of surface cover, vent to the atmosphere.

In the portions of the Containment Area where more permeable materials (refuse, debris, sand, and gravel) are present in the shallow subsurface, contaminants are expected to migrate more rapidly than in other areas of the site where soil consists predominantly of silt and clay. Soluble contaminants in soil and refuse close to or within the zone of groundwater fluctuation may become mobilized and migrate as solutes in groundwater. Infiltrating precipitation may also serve as a pathway for soluble soil contaminants to migrate to the groundwater in areas with no landfill materials. These contaminants may migrate to the groundwater, and contaminants in soil may solubilize and leach into groundwater. The mobility of organic compounds is expected to be limited by sorption onto fine-grained soil particles and organic material. The mobility of metals is expected to be limited by sorption to or formation of complexes with organic compounds in soils where soil pH is neutral to slightly basic (pH generally ranges between 6.8 and 8.7 in soil within the Containment Area).

At the boundary of the Containment Area, all debris and utility crossings have been removed and replaced with a 3-foot thick soil-bentonite slurry wall keyed into the underlying clay a minimum of 5 feet, as part of the Interim Remedial Action discussed previously. A groundwater extraction trench filled with drainage rock and equipped with sumps, pumps, and conveyance piping, is

located just inside the slurry wall to maintain groundwater levels below those outside the wall. This barrier and extraction trench is expected to effectively eliminate the horizontal migration of contaminants in the SWBZ from the Containment Area.

Vertical migration of contaminants in groundwater from the SWBZ to the IWBZ and DWBZ may occur because of a downward hydraulic gradient between these zones. This migration is expected to be limited because of the low permeability (10^{-7} centimeters per second [cm/s]) of the silty clay layers (i.e., Young Bay Mud) separating these zones. However, some of the older installed monitoring wells were constructed with screens that intersected both the SWBZ and the IWBZ. This created potential conduits for the downward migration of groundwater. As these monitoring wells were located within or adjacent to waste disposal areas, contamination may be expected to have migrated into the IWBZ. These wells have been properly abandoned and are no longer potential conduits.

5.2.2 Upland Areas Outside the Containment Barrier

The probable migration pathways for soil and groundwater contamination within the Upland Areas include surface erosion by wind or water, volatilization to air, downward migration of contaminants with infiltration of rainwater, and transport by groundwater. Shallow soil particles with adsorbed contaminants may be eroded by wind or rainfall, suspended and transported in air or surface water runoff, and redeposited either on or off site. Volatile contaminants detected in groundwater may volatilize and diffuse into the vadose zone. Similarly, volatile contaminants in soil may volatilize. Once in the vadose zone, the contaminants can migrate upward and vent to the atmosphere.

Infiltrating precipitation may serve as a pathway for soluble soil contaminants to migrate to the groundwater by leaching. The mobility of both organic and inorganic compounds is limited due to sorption to fine-grained soil particles and organic material. Across much of the Upland Areas, migration of soluble contaminants in groundwater is expected to be limited because of the low permeability and the adsorbing characteristics of the silty soils.

Soluble contaminants in soil and refuse close to or within the zone of groundwater fluctuation may also become mobilized and migrate as solutes in groundwater; however, the mobility of

organic compounds in groundwater is expected to be limited by sorption onto fine-grained soil particles and organic material. The mobility of metals is expected to be limited by sorption or formation of complexes with organic compounds in areas where the groundwater pH is neutral to slightly basic. In areas where soil is slightly acidic, metals may have a greater tendency to migrate.

Vertical migration of contaminants in groundwater from the SWBZ to the IWBZ and DWBZ may occur because of a downward hydraulic gradient between these zones. This migration is expected to be limited because of the low permeability (10^{-7} cm/s) of the silty clay layers separating these zones. However, some of the older installed monitoring wells were constructed with screens that intersected both the SWBZ and the IWBZ. This created potential conduits for the downward migration of groundwater. As these monitoring wells were located within or adjacent to waste disposal areas, contamination may be expected to have migrated into the IWBZ. These wells have been properly abandoned and are no longer potential conduits.

Migration of groundwater and dissolved contaminants in the SWBZ could be expected to be relatively fast in areas dominated by debris material and sand or gravel, where the hydraulic conductivity has been found up to about 5×10^{-3} cm/s. However, the SWBZ in most of IA-H1 consists of silty clay material with a relatively low hydraulic conductivity (3×10^{-5} to 1×10^{-7} cm/s). The soil surrounding the waste areas of IA-H1 consists of silty clay dredge material and natural deposits. Therefore, groundwater transport of dissolved contaminants is not expected to be significant. Additionally, the slurry wall and groundwater extraction trench will prevent future migration of contaminants from the Containment Area into the areas outside the slurry wall.

Where underground utilities have been buried in a permeable backfill, significant groundwater migration may occur in relatively permeable materials within the Upland Areas. For example, the permeable backfill surrounding the underground saltwater pipeline that passes along the northwestern boundary of the RCRA/Facility Landfill, or the Industrial Wastewater Treatment Plant (IWTP) pipeline that runs parallel to Dump Road, is considered a preferential pathway for groundwater transport or infiltrating precipitation.

5.2.3 Non-Tidal Wetland Areas Outside the Containment Barrier

The probable migration pathways for soil contamination within the Non-Tidal Wetland Areas include surface erosion by wind or water, downward migration of contaminants with infiltration of surface water or rainwater, and transport by groundwater. Shallow soil particles with adsorbed contaminants may be eroded by wind or rainfall, suspended and transported in air or surface water runoff, and redeposited either on or off site. Volatile contaminants detected in groundwater may volatilize and diffuse into the vadose zone. Similarly, volatile contaminants in soil may volatilize. Once in the vadose zone, the contaminants can migrate upward and vent to the atmosphere.

The fate of the metals found in the Non-Tidal Wetland Areas is controlled by reactions such as cation exchange, which would result in adsorption of contaminants to soil mineral surfaces or soil organic matter. Their fate is also likely to be controlled by precipitation reactions leading to the formation of secondary mineral phases. The retention of metals by soil depends on soil pH, mineralogical composition, oxidation-reduction conditions, and soil organic-matter content. The mobility of metals is limited by sorption to organic compounds in silty clay soils where soil pH is neutral to slightly basic. In the neutral to slightly basic and organic-rich conditions, the metals in the vadose zone will tend to remain adsorbed to soil; however, metals detected in soil below the fluctuating water table surface may dissolve.

Surface soil particles containing elevated metal concentrations are subject to wind and water erosion and may migrate as dispersed particulate dust in the atmosphere by wind action and/or as overland sediment load with surface runoff. The major transport pathways for the metals in the Non-Tidal Wetland Areas will be particulate migration as fugitive dust and dissolution into the surface water, followed by transport to the SWBZ groundwater. Once in the SWBZ, the metals could be transported through advection, diffusion, and dispersion; however, the hydraulic conductivity of the SWBZ in the vicinity of the wetlands is expected to be low due to the silty clay nature of the underlying soils, indicating that transport of metals in groundwater is not expected to be very effective. Additionally, metals in groundwater will be susceptible to adsorption to the silty clay and are likely to be further retarded against migration.

Surface soil particles containing PCBs are subject to wind and water erosion and may migrate either as fugitive dust in air or in surface water runoff. Natural attenuation processes are expected to be very slow for PCBs.

PAHs detected at various locations throughout the Non-Tidal Wetland Areas have a very low solubility in water, very low vapor pressure, and very high soil-water partitioning coefficient. Because PAHs do not readily volatilize and typically adsorb strongly to soil and organic matter, it is expected that they will remain adsorbed to soil with negligible transport to the SWBZ. Therefore, the fate of PAHs is likely to be dependent upon biodegradation processes, and concentrations in soil will likely diminish over time as a result of natural attenuation processes such as degradation and dispersion.

5.3 EXPOSURE PATHWAYS

Pathways for exposure of humans to Chemicals of Potential Concern (COPCs) in soil include ingestion, inhalation of soil particles, inhalation of chemical vapors released to the atmosphere from soil, and contact of soil with the skin. Pathways for exposure of ecological receptors to Chemicals of Potential Ecological Concern (COPEC) include direct ingestion, indirect ingestion of plant and animal tissues associated with COPEC uptake from soil or sediment with subsequent transfer through the food chain, and direct contact with COPECs in soil by plant roots and soil macroinvertebrates. Inhalation exposures to COPECs in dust by mammalian and avian receptors are considered low when compared to direct ingestion of soil and plant and animal food items. Surface water exposure is also considered a pathway for exposure in the Non-Tidal Wetland Areas.

Because groundwater within IA-H1 is unsuitable for potable water supplies and has no industrial or agricultural beneficial use due to high dissolved solids and low recovery (Water Board, 2004), there will be no exposure to humans from contaminated groundwater within the RCRA/Facility Landfill and its vicinity.

6. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

This section discusses the current and reasonably anticipated future land, groundwater, and surface water uses at Investigation Area H1 (IA-H1). This information can aid in identifying, enumerating, and characterizing human populations potentially exposed to site Chemicals of Potential Concern (COPCs) and in planning the most appropriate remedy for the site.

6.1 LAND USE

The Mare Island Final Reuse Plan (City of Vallejo, California, 1994) establishes the future land use at IA-H1 as open space/recreational. The Non-Tidal Wetland Areas (Wetlands A, B, C, and D) will remain habitat for the salt marsh harvest mouse (an endangered species), shore birds, migratory waterfowl, and other wildlife. The Non-Tidal Wetland Areas contain surface water in the rainy season and will continue to provide non-tidal marsh habitat for wildlife. Groundwater under IA-H1 is not suitable for human consumption and is therefore not a threat to drinking water; however, migration of the SWBZ contaminated groundwater may have an adverse ecological effect.

Currently, fencing and gates secure the site. After construction of the remedy, some portions of the site may be used as open space/recreational; however, as discussed in Section 8.2.1.2.3, public access to the Containment Area will be prohibited with the proposed remedy.

The United States Department of the Navy (DON) is responsible for ensuring that any change in land use does not diminish the Containment Area cap's ability to achieve the remedial action objectives (RAOs). This Remedial Action Plan (RAP)/Record of Decision (ROD)/Resource Conservation and Recovery Act (RCRA) Closure Plan prohibits structural improvements that would affect the integrity of the cap as well as other elements of the remedy. If there is interest in modifying land use at the site, proposed changes in physical layout or site use shall be brought to the attention of appropriate state and federal agencies for review and approval.

7. SUMMARY OF SITE RISKS

Risk assessments provide an evaluation of the potential threat to human health and the environment in the absence of remedial action. They also provide the basis for determining whether remedial action is necessary and the justification for performing remedial actions, as well as identify the contaminant and exposure pathways that will be addressed by the remedial actions. Ambient/background levels of materials may contribute significantly to the overall risk levels. Naturally occurring materials vary in concentration and risk depending on the content of local soils.

7.1 HUMAN HEALTH RISK ASSESSMENT

Three separate risk assessments were prepared for Investigation Area H1 (IA-H1) (Weston Solutions, Inc., [WESTON], 2005b). A Screening Level Risk Evaluation was conducted for soil, sediment, and groundwater within the proposed Containment Area; a baseline Human Health Risk Assessment (HHRA) was conducted for soil, sediment, and groundwater in the Upland Areas outside the Containment Barrier; and a baseline HHRA was conducted for soil, sediment, groundwater, and surface water in the Non-Tidal Wetland Areas outside the Containment Barrier. The shallow groundwater was evaluated in two separate areas as divided by the Containment Barrier. The intermediate and deep groundwater was evaluated on a site-wide basis. The HHRA included an evaluation of potential exposures under an unchanged site configuration (i.e., current land use) and under a modified site configuration (assuming future land redevelopment). The current land use at IA-H1 is open space, and the final Mare Island reuse plan (City of Vallejo, California, 1994) establishes the future land use at IA-H1 as open space.

Based on an evaluation of current and expected future uses of the site, the following human receptors were evaluated at the three exposure areas (i.e., the Containment Area, Upland Areas, and Non-Tidal Wetland Areas) within IA-H1:

- Current/future commercial/industrial worker at the Containment Area (adult)
- Current/future recreational users at the Upland and Non-Tidal Wetland Areas (1- to 17-year-old children)

- Hypothetical current/future residents at the Containment Area, Upland Areas, and Non-Tidal Wetland Areas (adults and 0- to 6-year-old children) Note that this scenario is not discussed in this document because residential use is not being considered for the site.
- Current/future construction workers at the Upland and Non-Tidal Wetland Areas (adult)

The 0 to 2 feet below ground surface (bgs) soil zone was used to represent current soil conditions. The 0 to 10 feet bgs mixed soil zone was used to represent future soil conditions. The mixed soil zone was evaluated to represent conditions in the event of any construction or digging that may occur at the site. Results from notable exposure scenarios are described in the following sections and are summarized in Table 7-1.

7.1.1 Current Exposure Scenario

Containment Area—Commercial/Industrial Worker

The total lifetime excess cancer risk estimate for the current exposure scenario to a commercial/industrial worker for all exposure media within the Containment Area (i.e., soil and groundwater) is 1.9×10^{-3} . Current risk scenarios are based on evaluating soil in the 0 to 2 feet bgs zone. The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 2 feet bgs zone is 2.9×10^{-4} . The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Containment Area is 1.6×10^{-3} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 3.8×10^{-6} . The estimated hazard index (HI) is equal to 28 for combined soil and groundwater exposure. The estimated non-cancer HI for soil exposure is equal to 6.0. The estimated HI for shallow groundwater exposure is equal to 22, and the estimated HI for combined intermediate and deep groundwater is equal to 0.05.

The chemicals of concern (COCs) for the current exposure scenario for soil include arsenic, Aroclor-1248, Aroclor-1254, Aroclor-1260, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, naphthalene, 1,4-dichlorobenzene, and 1,2,3-trichloropropane. For the shallow groundwater, the COCs are bis(2-chloroethyl)ether, benzene, chloroethane, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,2-dichloroethene, tetrachloroethene, vinyl chloride, 2-methylnaphthalene, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 1,1,2-trichloroethane, and xylenes.

Upland Areas—Recreational User

For the Upland Areas, the total reasonable maximum exposure (RME) lifetime excess cancer risk estimate for the current exposure scenario to a recreational user for all exposure media (i.e., soil and groundwater) is 5.2×10^{-5} . The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 2 feet bgs zone is 5.0×10^{-5} . Arsenic at or below ambient/background levels for this area accounts for most of the carcinogenic risk. The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Upland Areas is 1.1×10^{-6} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater underlying the Upland Areas is 1.4×10^{-6} . The estimated HI is equal to 0.30 for combined soil and groundwater exposure. The estimated HI for soil exposure is equal to 0.21, the estimated HI for shallow groundwater exposure is equal to 0.068, and the estimated HI for intermediate and deep groundwater exposure is equal to 0.018.

The COCs for the current exposure scenario for the Upland Areas based on cancer risk estimates include arsenic and benzo(a)pyrene for soil. The total non-cancer HI for combined exposure media did not exceed 1. No individual chemical had an individual HI greater than 1, and no individual target organ non-cancer HI exceeded 1. No COCs were identified based on adverse non-cancer health effects to humans.

Non-Tidal Wetland Areas—Recreational User

For the Non-Tidal Wetland Areas, the total RME lifetime excess cancer risk estimate for the current exposure scenario to a recreational user for all exposure media (i.e., sediment, groundwater, and surface water) is 8.4×10^{-5} . Arsenic at or below ambient/background soil levels for this area accounts for most of the carcinogenic risk. The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 2 feet bgs zone is 6.5×10^{-5} . The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Non-Tidal Wetland Areas is 1.1×10^{-6} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 1.4×10^{-6} . The total lifetime excess cancer risk estimate for exposure to surface water within the Non-Tidal Wetland Areas is 1.7×10^{-5} . The estimated HI is equal to 0.31

for combined sediment, groundwater, and surface water exposure. The estimated HI for soil exposure is equal to 0.20, the estimated HI for shallow groundwater exposure is equal to 0.068, the estimated HI for intermediate and deep groundwater exposure is equal to 0.018, and the estimated HI for surface water exposure is equal to 0.02.

The COCs for the current exposure scenario at the Non-Tidal Wetland Areas based on cancer risk estimates include arsenic for soil and surface water. The total non-cancer HI for the current exposure scenario did not exceed 1. No individual chemical had an individual HI greater than 1, and no individual target organ non-cancer HI exceeded 1. No risk drivers were identified based on adverse non-cancer health effects to humans.

7.1.2 Future Exposure Scenario

Containment Area—Commercial/Industrial Worker

The total lifetime excess cancer risk estimate for the future exposure scenario to a commercial/industrial worker for all exposure media within the Containment Area (i.e., soil and groundwater) is 1.9×10^{-3} . Future risk scenarios are based on evaluating soil in the 0 to 10 feet bgs zone. The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 10 feet bgs zone is 2.9×10^{-4} . The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Containment Area is 1.6×10^{-3} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 3.8×10^{-6} . The estimated HI is equal to 28 for combined soil and groundwater exposure. The estimated HI for soil exposure is equal to 5.9, the estimated HI for shallow groundwater exposure is equal to 22, and the estimated HI for intermediate and deep groundwater exposure is equal to 0.05.

The COCs for the future exposure scenario at the Containment Area for soil include arsenic, Aroclor-1248, Aroclor-1260, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, naphthalene, 1,4-dichlorobenzene, and 1,2,3-trichloropropane. For the shallow groundwater, the COCs include bis(2-chloroethyl)ether, benzene, chloroethane, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,2-dichloroethene, tetrachloroethene, 1,1,2-trichloroethane, vinyl chloride, 2-methylnaphthalene, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and xylenes.

Upland Areas—Recreational User

For the Upland Areas, the total RME lifetime excess cancer risk estimate for the future exposure scenario to a recreational user for all exposure media (i.e., soil and groundwater) is 5.5×10^{-5} . The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 10 feet bgs zone is 5.3×10^{-5} . The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Uplands Area is 1.1×10^{-6} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 1.4×10^{-6} . The estimated HI is equal to 0.36 for combined soil and groundwater exposure. The estimated HI for soil exposure is equal to 0.27, the estimated HI for shallow groundwater exposure is equal to 0.068, and the estimated HI for intermediate and deep groundwater exposure is equal to 0.018.

The COCs for the future exposure to a recreational user based on cancer risk include arsenic, total polychlorinated biphenyls (PCBs), and benzo(a)pyrene in soil. Arsenic at or below ambient/background levels for this area accounts for most of the carcinogenic risk (about 90 percent). No chemical had an individual non-cancer HI greater than 1 and no individual target organ non-cancer HIs exceeded 1. No COCs were identified based on adverse non-cancer health effects to humans.

Upland Areas—Construction Worker

For the Upland Areas, the total RME lifetime excess cancer risk estimate for the future exposure scenario to a construction worker for all exposure media (i.e., soil and groundwater) is 9.2×10^{-6} . The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 10 feet bgs zone is 8.8×10^{-6} . The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Upland Areas is 2.1×10^{-7} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 2.7×10^{-7} . The estimated HI is equal to 1.5 for combined soil and groundwater exposure. The estimated HI for soil exposure is equal to 1.2, the estimated HI for shallow groundwater exposure is equal to 0.22, and the estimated HI for intermediate and deep groundwater is 0.08.

The only COC for future exposure to a construction worker based on cancer risk is arsenic for soil. No chemical had an individual non-cancer HI greater than 1 and no individual target organ non-cancer HI exceeded 1. No COCs were identified based on adverse non-cancer health effects to humans.

Non-Tidal Wetland Areas—Recreational User

For the Non-Tidal Wetland Areas, the total RME lifetime excess cancer risk estimate for the future exposure scenario to a recreational user for all exposure media (i.e., sediment, groundwater, and surface water) is 8.3×10^{-5} . The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 10 feet bgs zone is 6.4×10^{-5} . Arsenic at or below ambient/background levels for this area accounts for most of the carcinogenic risk (about 95 percent). The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Non-Tidal Wetland Areas is 1.1×10^{-6} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 1.4×10^{-6} . The total lifetime excess cancer risk estimate for exposure to surface water within the Non-Tidal Wetland Areas is 1.7×10^{-5} . The estimated HI is equal to 0.36 for combined soil, groundwater, and surface water exposure. The estimated HI for soil exposure is equal to 0.25, the estimated HI for shallow groundwater exposure is equal to 0.068, the estimated HI for intermediate and deep groundwater exposure is equal to 0.018, and the estimated HI for surface water exposure is equal to 0.02.

The only COC for the future exposure scenario to a recreational user based on cancer risk is arsenic in sediment and surface water. No chemical had an individual non-cancer HI greater than 1, and no individual target organ non-cancer HI exceeded 1. No COCs were identified based on adverse non-cancer health effects to humans.

Non-Tidal Wetland Areas—Construction Worker

For the Non-Tidal Wetland Areas, the total RME lifetime excess cancer risk estimate for the future exposure scenario to a construction worker for all exposure media (i.e., sediment and groundwater) is 1.1×10^{-5} . The total lifetime excess cancer risk estimate for exposure to soil within the 0 to 10 feet bgs zone is 1.1×10^{-5} . The total lifetime excess cancer risk estimate for exposure to shallow groundwater underlying the Non-Tidal Wetland Areas is 2.1×10^{-7} . The total lifetime excess cancer risk estimate for exposure to intermediate and deep groundwater is 2.7×10^{-7} . The estimated HI is equal to 1.6 for combined sediment and groundwater exposure. The estimated HI for sediment exposure is equal to 1.3, the estimated HI for shallow groundwater exposure is equal to 0.22, and the estimated HI for intermediate and deep groundwater exposure is equal to 0.059.

The only COC for future exposure to a construction worker based on cancer risk is arsenic in soil. Although the total non-cancer HI for the future exposure for a construction worker exceeded 1, no individual chemical had an individual HI greater than 1, and no individual target organ non-cancer HI exceeded 1.

7.1.3 Ambient/Background Risk

Ambient/background levels of materials may contribute significantly to the overall risk levels at a hazardous waste site. Ambient/background concentrations in soil vary as a result of both natural and anthropogenic soil-forming processes. Thus, the contribution of ambient/background levels to the total risk needs to be considered when evaluating the risk posed by IA-H1. Within IA-H1, arsenic is a main contributor to the overall cancer risk. The 95 percent upper confidence limit (95UCL) ambient/background arsenic level identified for Mare Island is 14 milligrams per kilogram (mg/kg) and the 95th percentile ambient/background concentration is 36 mg/kg. As shown in the Final RI (WESTON, 2005a), the contribution of the ambient/background level of arsenic to the total risk is at least 90 percent. When evaluating overall risk the contribution of high ambient levels of arsenic needs to be considered to properly evaluate the man made contribution to risk elevating contamination and even more importantly the potential for cleaning up contamination and reducing risk. Excluding the arsenic-related risk from the total soil risk results in risks ranging from 1×10^{-6} to 7×10^{-6} in the Upland Areas and from 1×10^{-6} to 3×10^{-6} in the Non-Tidal Wetland Areas, which are within the EPA's risk management range of 10^{-4} to 10^{-6} .

7.2 ECOLOGICAL RISK ASSESSMENT

Three separate ecological risk assessments (ERAs) were prepared for IA-H1, one for each of the exposure areas (WESTON, 2005a). The ERA for the Containment Area consisted of a comparison to published ecological screening benchmarks as well as a comparison of intake for selected vertebrate receptors to avian and mammalian toxicity values except where noted in the tables. For the Upland Areas and the Non-Tidal Wetland Areas, a combined screening-level and baseline ERA was conducted for each area. The approach for the screening-level ERA corresponds to Steps 1 and 2 of the eight-step Ecological Risk Assessment Process for Superfund (United States Environmental Protection Agency [EPA], 1997). The approach for the baseline ERA corresponds to Steps 3 through 8 of the EPA Superfund guidance (EPA, 1997). The

baseline ERA was performed to further refine the conclusions of the screening-level assessment to determine whether the level of risk at the site is acceptable.

7.2.1 Containment Area

A screening-level ERA was performed for the Containment Area to provide sufficient documentation of the risk posed by the Resource Conservation and Recovery Act (RCRA)/Facility Landfill to support the presumptive remedy (containment). The screening level ERA for the Containment Area is based on the most conservative exposures that are expected to occur, including direct contact with contaminated soil by plants and soil-dwelling organisms, incidental ingestion of contaminated soil by birds and mammals while grooming, eating, or foraging, and the ingestion of contaminants after uptake of constituents into sources of food. Analytical data for the Containment Area was screened against acceptable and conservative risk-based ecological screening benchmark values to identify the potential for ecological impacts. Screening benchmark values used in the evaluation of the Containment Area included Ecological Soil Screening Levels (EPA, 2003), Oak Ridge National Laboratory On-line Risk Assessment Information System (ORNL RAIS) ecological screening levels (ORNL RAIS, 2004), and EPA Region 5 RCRA Ecological Screening Levels (EPA, 2002). The range of detected concentrations in all soils (i.e., 0 to 10 feet) was compared to the most conservative screening values identified from these sources.

In the Containment Area, numerous metals, polycyclic aromatic hydrocarbons (PAHs), phthalates, PCBs, and volatile organic compounds (VOCs) exceed ecological screening levels for protection of plants, soil invertebrates, and wildlife by more than one order of magnitude, suggesting a significant and immediate risk. Based on these exceedances, a significant and immediate risk to ecological receptors exists for the area within the Containment Barrier. Since a cap will be installed on the Containment Area to eliminate the exposure pathway, the ecological effects of these chemicals were not evaluated further.

7.2.2 Upland Areas

A combined screening-level and baseline ERA was prepared for the Upland Areas. Field measured soil, groundwater, surface water (from the non-tidal wetlands), and tissue (i.e., plant,

earthworm, and small mammal) data collected for the Onshore ERA Tetra Tech EM, Inc. [TtEMI, 2002] was used in the ERA for the Upland Areas.

The following assessment endpoints were identified for the upland habitats of Mare Island and include the protection of:

- upland plant communities
- communities of soil-dwelling organisms
- populations of herbivorous mammals
- populations of insectivorous mammals
- populations of passerine birds
- populations of raptors
- populations of large carnivorous mammals

Direct comparison to media-based effects benchmarks is used to measure exposure of plants and soil-dwelling organisms. Food-chain modeling is used to measure exposure of vertebrate receptors in the ERA. The ingestion of prey and incidental ingestion of soil represent the primary routes of exposure to the Upland Areas receptors; consumption of water from the non-tidal wetlands is also considered. The Hazard Quotient (HQ) method is used to quantify risk from food chain exposure. For the HQ method, the potential risk posed to target receptors is assessed by comparing estimated daily intake with toxicity reference values (TRVs). Five vertebrate species (two birds and three mammals) were chosen as representative receptors for food-chain analysis:

- California vole (*Microtus californicus*)
- Ornate shrew (*Sorex ornatus*)
- Western meadowlark (*Sturnella neglecta*)
- Northern harrier (*Circus cyaneus*)
- Gray fox (*Urocyon cinereoargenteus*)

Two of the species listed above represent guilds of upper trophic level predators common in the upland habitats of Mare Island. The top predators include raptors (represented by the northern harrier) and large carnivorous mammals (represented by the gray fox). Small herbivorous and

insectivorous mammals (represented by the California vole and ornate shrew) and passerine birds (represented by the western meadowlark) are included in the food-chain analysis.

For the purposes of the risk assessment, both screening-level and baseline exposure assumptions were used to estimate exposure doses and risk. The estimate of risk expressed as a screening-level analysis is based on reasonably conservative exposure assumptions, such as maximum exposure point concentrations and 100 percent site use. The use of screening-level assumptions represents a worst-case scenario for the areas of concern. The baseline exposure assumptions represent a more reasonable scenario for the area of concern. For each receptor, only those chemicals of potential ecological concern (COPEC) with a low TRV-based HQ greater than 1 under the screening-level analysis were evaluated in the baseline analysis. The baseline risk is based on adjusting the exposure point concentration and the site use factor to more reasonable assumptions.

The baseline risk analysis indicates that exposure to dioxins, dichlorodiphenyldichloroethane (DDD), PCBs, benzo(a)pyrene, aluminum, arsenic, cadmium, chromium, copper, lead, manganese, nickel, selenium, vanadium, and zinc in the Upland Areas soil pose a risk to Upland Areas receptors. Aluminum in soil poses a significant or immediate risk to the California vole, ornate shrew, and western meadowlark. Dioxins and vanadium in soil pose a significant or immediate risk to the ornate shrew and chromium poses a significant or immediate risk to the western meadowlark. There is a potential for risk to the California vole exposed to nickel and vanadium; a potential risk to the western meadowlark exposed to dioxins, cadmium, copper, lead, nickel, selenium, zinc, DDD, and benzo(a)pyrene; a potential risk to the northern harrier exposed to PCBs and lead; a potential risk to the gray fox exposed to PCBs, aluminum, and selenium; and a potential risk to the ornate shrew exposed to arsenic, cadmium, copper, lead, manganese, nickel, selenium, and zinc. While aluminum, arsenic, cadmium, chromium, manganese, nickel, vanadium, and benzo(a)pyrene in soil in the Upland Areas do pose an ecological risk, the metal contaminants may be present at ambient/background levels in most cases. Aluminum was not considered further since aluminum is only considered to be toxic to ecological receptors if the pH is less than 5.5, which is not the case at this site.

7.2.3 Non-Tidal Wetland Areas

A combined screening-level and baseline ERA was prepared for the Non-Tidal Wetland Areas outside of the Containment Area. Field measured sediment, surface water, and tissue data (i.e., plants, pickleweed, benthic invertebrates, amphibians, and small mammals) collected for the Onshore ERA (TtEMI, 2002) was used in the ERA for the Non-Tidal Wetland Areas.

The following assessment endpoints were identified for the non-tidal wetland habitats and include the protection of:

- wetland plant communities
- communities of benthic invertebrates
- populations of small mammals (or protection of individuals, in the case of the salt marsh harvest mouse)
- populations of shorebirds
- populations of wading birds
- populations of waterfowl
- populations of raptors
- populations of large carnivorous mammals

Direct comparison to media-based effects benchmarks is used to measure exposure of wetland plants and sediment-dwelling organisms. Food-chain modeling is used to measure exposure of vertebrate receptors in the ERA. The ingestion of prey and incidental ingestion of sediment and surface water represent the primary routes of exposure to the Non-Tidal Wetland Areas receptors. The HQ method is used to quantify risk from food chain exposure. For the HQ method, the potential risk posed to target receptors is assessed by comparing estimated daily intake with TRVs. Four vertebrate species (three birds and one mammal) were chosen as representative receptors for food-chain analysis to evaluate risks to small mammals, shorebirds, waterfowl, and wading birds:

- Salt marsh harvest mouse (*Reithrodontomys raviventris*)
- Killdeer (*Charadrius vociferous*)
- Mallard (*Anas platyrhynchos*)
- Great blue heron (*Ardea herodias*)

The two upper trophic level predators evaluated for the Upland Areas (i.e., northern harrier and gray fox) were also chosen for the food-chain analysis for the non-tidal wetland habitat since these receptors may roam throughout both habitats.

Two of the four species listed above represent guilds of upper trophic level predators common in the wetland habitats of Mare Island. These guilds include insectivorous birds (represented by the killdeer) and carnivorous birds (represented by the great blue heron). The salt marsh harvest mouse is a herbivorous mammal that feeds primarily on pickleweed and saltgrass. The salt marsh harvest mouse was selected for food-chain analysis because it is a federal and state endangered species that occurs in the area; its endangered status requires that individual mice be protected.

Inhalation of volatile contaminants released from soil and groundwater was also evaluated for this sensitive species. Waterfowl (represented by the mallard) were included in the food-chain analysis because they are protected under the Migratory Bird Treaty Act (MBTA) and are potential prey for raptors.

For the purpose of the risk assessment, both screening-level and baseline exposure assumptions were used to estimate exposure doses and risk. The estimate of risk expressed as a screening-level analysis is based on reasonably conservative exposure assumptions, such as maximum exposure point concentrations and 100 percent site use. The use of screening-level assumptions represents a worst-case scenario for the areas of concern. The baseline exposure assumptions represent a more reasonable scenario for the area of concern. For each receptor, only those COPEC with a low TRV-based HQ greater than 1 under the screening-level analysis were evaluated in the baseline analysis. The baseline risk is based on adjusting the exposure point concentration and the site use factor to more reasonable assumptions.

The baseline analysis indicates that exposure to PCBs, benzo(a)pyrene, aluminum, antimony, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc in soil pose a risk to Non-Tidal Wetland Areas ecological receptors. PCBs in sediment and/or prey tissue pose a significant or immediate risk to the gray fox, the killdeer, and the salt marsh harvest mouse. Chromium, manganese, mercury, and selenium also pose a significant or immediate risk to the killdeer, while aluminum, antimony, lead, manganese, nickel, vanadium, and zinc pose a significant or immediate risk to the salt marsh harvest mouse. Lead in sediment and/or prey tissue pose a potential risk to the mallard (breeding and non-breeding), northern

harrier, great blue heron, and killdeer. Benzo(a)pyrene, aluminum, barium, cadmium, copper, nickel, and zinc also pose a potential risk to the killdeer. PCBs pose a potential risk to the northern harrier and great blue heron and aluminum and selenium pose a potential risk to the gray fox. While aluminum, barium, cadmium, chromium, copper, manganese, mercury, nickel, vanadium, zinc, and benzo(a)pyrene in sediment in the Non-Tidal Wetland Areas do pose an ecological risk, the metal contaminants may be present at ambient/background levels in most cases. Aluminum was not considered further since aluminum is only considered to be toxic to ecological receptors if the soil pH is less than 5.5, which is not the case at this site.

7.2.4 Determination of Cleanup Levels

Cleanup levels were not determined for the Containment Area as the presumptive remedy for this area is containment, which will eliminate the exposure pathway. Cleanup levels for the areas outside of the Containment Area were determined by the identification of hot spot screening criteria. Hot spot screening criteria were developed based on risks to human health, threats to groundwater, and risks to ecological receptors. Development of hot spot screening criteria is detailed in the Final Feasibility Study (FS) (WESTON, 2006a).

Screening criteria based on human health risks were developed by using the risk equations presented in the HHRA and back-calculating a chemical concentration to represent a hot spot screening level. Hot spot screening levels for human health risk include chemical concentrations that result in either a 1×10^{-5} cancer risk level or a noncarcinogenic HI value of 1. For the child recreational user no cumulative HI was greater than 1. For the Current and future construction worker the cumulative HIs including all media, chemicals, and target organs were 1.5 and 1.6 respectively. Outside the Containment Area no individual chemical or target organ exceeded an HI of 1 for either the child recreational user or the construction worker. With arsenic excluded, a sample location is defined as a hot spot for human health if it contains contaminants exceeding a cancer risk of 1×10^{-5} or an individual chemical HI of 1 for the recreational child or construction worker receptors, whichever was lower. When arsenic is included, a sample location is defined as a hot spot if it contains contaminants exceeding a cancer risk of 1×10^{-4} or an HI of 1 (Note that ambient/background arsenic 95UCL levels in soil for Mare Island equal a 1×10^{-4} cancer risk level.) Removal of material that exceeds health hot spot screening criteria will leave a risk in the range of overall background or better for non-arsenic materials. The hot spot criteria for threats

to groundwater were developed based on the remaining beneficial use for groundwater as potential discharge to wetlands. Because the site specific risk assessment did not identify any surface water risk other than arsenic, the threat to groundwater was determined to be free product, or TPH.

The upland habitat ecological screening levels are based on chemical concentrations that correspond to a HQ of 1, 3, 5, and 10 for adverse effects using the high TRV. The non-tidal wetland habitat ecological screening levels are based on chemical concentrations that correspond to a HQ of 1 for adverse effects using the high TRV for non-listed specials and using the low TRV for the salt marsh harvest mouse, a listed species.

Table 7-2 presents the development of cleanup levels for surface soil (0 to 2 feet) in the Upland Areas based on human health, threat to groundwater, and ecological hot spot screening criteria. Tables 7-3 through 7-5 present subsurface soil hot spot screening criteria at three levels: 2 to 4 feet, 4 to 10 feet, and greater than 10 feet in depth for the Upland Areas soil. Upland Areas cleanup levels for the 2- to 4-foot zone are based on human health, threat to groundwater, and ecological hot spot screening criteria. Upland Areas cleanup levels for the 4- to 10-foot zone are based on human health and threat to groundwater hot spot screening criteria. Upland Areas cleanup levels for the greater than 10-foot zone are based on threat to groundwater hot spot screening criteria. Tables 7-6 through 7-7 present the development of cleanup levels for the sediment (0 to 2 feet) and subsurface soil (4 to 10 feet) in the Non-Tidal Wetland Areas. Cleanup levels for the sediment in the Non-Tidal Wetland Areas are based on human health, threat to groundwater, and ecological hot spot screening criteria. Non-Tidal Wetland Areas cleanup levels for the 4- to 10-foot zone are based on human health and threat to groundwater hot spot screening criteria. The various depth intervals have varying screening levels based on receptor populations (e.g., recreational user, construction worker, ecological receptor, etc.) expected to be exposed to each soil depth.

Several of the chosen hot spot levels for the various alternatives defaulted to ambient/background values due to threats to either human or ecological receptors because most hot spot screening criteria are lower than ambient/background. For the Upland Areas an average threshold is used to guide the remediation. The average threshold is compared to existing

concentration results at individual locations to identify hot spots for excavation and the subsequent confirmation sample results to determine if further excavation is required.

In the Non-Tidal Wetland Areas in cases where chosen hot spot levels defaulted to ambient/background values, two hot spot levels are proposed based on: an average threshold and an upper threshold value. The average threshold represents the acceptable ecological RBC. The upper threshold is a “do-not-exceed” hot spot level for discrete samples. Due to the high level of uncertainty associated with the avian TRV for barium, the avian RBCs were not used in selecting the hot spot thresholds. Threshold values are not presented for tin due to the uncertainty associated with the TRVs for this metal, which were based on the organotin, tributyltin oxide. Organotins are more toxic than inorganic tins and have not been detected in non-tidal wetland sediments.

8. DESCRIPTION OF REMEDIAL ALTERNATIVES

8.1 REMEDIAL ACTION OBJECTIVES

This section describes the remedial alternatives selected for detailed analysis in the Investigation Area H1 (IA-H1) Feasibility Study (FS) (Weston Solutions, Inc. [WESTON], 2006a). The alternatives are based on the Remedial Investigation (RI) (WESTON, 2005a) findings, human health and ecological risk assessments, and a review of applicable or relevant and appropriate requirements (ARARs). The following overall Remedial Action Objectives (RAOs) were developed for IA-H1 to focus the FS and define the scope of potential cleanup activities.

8.1.1 Containment Area

The objectives for the presumptive remedy at landfill sites include containment of the landfill mass, measures to collect and manage landfill gas (if present), and measures to collect and manage landfill leachate affecting groundwater quality (United States Environmental Protection Agency [EPA], 1996).

8.1.1.1 Landfill Refuse Remedial Action Objective

The primary exposure pathways for landfill refuse and contaminated media are dermal contact, ingestion, and inhalation of compounds. Surface exposure is currently controlled with a soil cover. Erosion by wind and rain could potentially expose landfill refuse and contaminated media, thereby potentially enhancing risks of ingestion and inhalation of chemicals of concern (COCs). In addition, erosion could result in migration of contaminants off site.

The general RAO for the Containment Area is to protect human and ecological receptors from exposure to landfill refuse and soil contamination by eliminating exposure pathways and contaminant migration.

8.1.1.2 Groundwater Remedial Action Objective

Groundwater at IA-H1 is not suitable for human consumption due to high levels of dissolved solids and low production rates as evaluated by the California Environmental Protection Agency

San Francisco Bay Regional Water Quality Control Board (Water Board, 2004). The landfill refuse and contaminated soil are therefore not a threat to drinking water. However, migration of the contaminated groundwater may have an adverse ecological effect on target receptors due to exposure through ingestion, inhalation, or dermal contact (WESTON, 2006a).

The RAO for groundwater is to minimize the effects of landfill refuse and soil contaminants on groundwater quality (e.g. infiltration with rainwater) and eliminate migration of contaminated groundwater to potential off-site receptors by containing contaminated groundwater within the Containment Area.

8.1.1.3 Landfill Gas Remedial Action Objective

A limited landfill gas investigation indicates that gases, including methane, carbon dioxide, and volatile organic compounds (VOCs) are being generated, primarily within the interim status Resource Conservation and Recovery Act (RCRA) Landfill. The general RAO for landfill gas is to protect human and ecological receptors by minimizing exposure pathways and gas migration.

8.1.2 Upland Areas

Based on the human health and threat to groundwater COCs and the chemicals of ecological concern (COECs), the exposure pathways and receptors present at IA-H1, and the calculated acceptable constituent level (i.e., the Preliminary Site-Specific Cleanup Goal) for each exposure pathway, the following RAOs were developed for the IA-H1 Upland Areas:

- Reduce exposure via ingestion, direct contact, and inhalation of site soil containing COC concentrations that present an area-wide cancer risk estimate from anthropogenic contaminations of 1×10^{-5} or noncarcinogenic adverse health effects resulting in a hazard index (HI) of 1.
- Reduce exposure to COECs present within the soil posing immediate and significant or potential risk to the gray fox, northern harrier, western meadowlark, ornate shrew, and California vole.
- Reduce downward migration of soil COCs to the shallow water-bearing zone (SWBZ) underlying IA-H1.
- Reduce migration of COCs present within surface soil in IA-H1 toward the sediment and surface water of the Non-Tidal Wetland Areas of IA-H1.

- Control direct exposure and protect future workers from the extremely low residual risk posed by potential munitions or explosives of concern (MEC) and radiological material in IA-H1.

8.1.3 Non-Tidal Wetland Areas

Based on the human health and threat to groundwater COCs and the COECs, the exposure pathways and receptors present at IA-H1, and the calculated acceptable constituent level for each exposure pathway, the following RAOs were developed for the IA-H1 Non-Tidal Wetland Areas:

- Reduce exposure via ingestion, direct contact, and inhalation of site soil containing COC concentrations that present an area-wide cancer risk estimate from anthropogenic contamination of 1×10^{-5} or noncarcinogenic adverse health effects resulting in a HI of 1.
- Reduce exposure to COECs present within the sediment posing immediate and significant or potential risk to the killdeer, great blue heron, mallard, and salt marsh harvest mouse.
- Reduce exposure via ingestion of surface water containing COC concentrations presenting an area-wide cancer risk estimate of 1×10^{-5} to humans at the Non-Tidal Wetland Areas.
- Control direct exposure and protect future workers from the extremely low residual risk posed by potential MEC and radiological material in IA-H1.

8.2 REMEDIAL ALTERNATIVES

The remedial alternatives for the Containment Area, Upland Areas, and Non-Tidal Wetland Areas involve combinations of process options. Each alternative was analyzed in detail during the FS process and is summarized below.

8.2.1 Containment Area Alternatives

Three remedial alternatives were assembled based on process options remaining from the technology screening process, site-specific conditions, and EPA guidance. These alternatives are as follows:

- Alternative 1—No Action
- Alternative 2A—Variable Multilayer Cap, Groundwater Containment, Gas Monitoring, and Institutional Controls

- Alternative 2B—RCRA Multilayer Cap, Groundwater Containment, Gas Monitoring, and Institutional Controls
- Alternative 3—Removal and Off-site Disposal

Because the alternatives developed for the Containment Area are based on EPA presumptive remedy guidance for streamlining the FS process (EPA, 1993; 1996), the alternatives did not undergo further screening. The alternatives for the Containment Area are described below.

8.2.1.1 Alternative 1—No Action

Under the “No Action” alternative, no remedial actions will be implemented. Actions required for interim status of the RCRA-regulated units within IA-H1 would be continued; however, no other actions would be taken. The “No Action” alternative is reviewed to provide a baseline against which other alternatives can be compared.

8.2.1.2 Alternative 2A—Variable Multilayer Cap, Groundwater Containment, Gas Monitoring, and Institutional Controls

Alternative 2A consists of land use and access restrictions, a variable multilayer cap (with surface drainage and erosion controls), a groundwater Containment Barrier, an extraction trench for groundwater containment, and gas venting and monitoring. A multilayer cap, described in Sections 8.2.1.2.1 and 8.2.1.2.2, will be implemented under this alternative to isolate landfill refuse, eliminate direct contact with surface soil, reduce erosion, reduce surface soil contaminant migration, and limit surface water infiltration. The Final RI (WESTON, 2005a) did not attempt to fully characterize the RCRA/Facility Landfill content because of its heterogeneous nature and because the presumptive remedy for landfills, i.e., containment, would be the most likely remedy. A RCRA Subtitle C equivalent multilayer cap will cover the RCRA interim status hazardous waste landfill, the Industrial Wastewater Treatment Plant (IWTP), and the Facility Landfill inside the Containment Area (for a total of approximately 32 acres). The footprint of the RCRA and Facility Landfill includes the bulk of waste disposed of within the Containment Area, as evidenced by the higher topography in this portion of the Containment Area. A RCRA Subtitle D multilayer cap (non-RCRA hazardous waste cap) will cover the remaining areas within the Containment Barrier (approximately 40 acres). The IWTP pipeline was reportedly

flushed and cleaned when the IWTP ceased operations. The IWTP pipeline was video surveyed, cleaned, and rinsate tested in accordance with a DTSC-approved work plan, in November 2005 (WESTON, 2006b). Areas around the pipeline do not show any contamination inconsistent with the surrounding IA-H1 soils. Closure of the IWTP pipe will be accomplished through implementation of the CERCLA remedies in the areas of IA-H1 that include the pipe run. Figure 8-1 shows the respective areas. A fence will be constructed around the Containment Area to prevent public access.

Both multilayer caps, as described in Sections 8.2.1.2.1 and 8.2.1.2.2, will satisfy performance requirements contained in California Code of Regulations (CCR), Title 27, Chapter 3, Subchapter 5, Article 2, Section 21140. The portion of the cap over the RCRA regulated units and Facility Landfill will also comply with Title 40 Code of Federal Regulations (CFR) RCRA Subtitle C regulations. Public access will not be allowed for the Containment Area with this proposed remedy.

8.2.1.2.1 RCRA Equivalent Cap

A RCRA Subtitle C cap works by maintaining a multilayer, low-permeability cover over the waste to stabilize surface soil and reduce surface water infiltration, which in turn limits leachate and landfill gas generation. Performance standards for caps under CCR Title 22, CCR Title 27, and Title 40 CFR require minimum liquid migration through the wastes, low maintenance cover requirements, efficient site drainage, high resistance to damage by settling or subsidence, and a permeability lower than or equal to the underlying liner system or natural soils. The Young Bay Mud underlying the IA-H1 area has a permeability of 2×10^{-7} centimeters per second (cm/s) as reported in the Final RI (WESTON, 2005a).

The standard RCRA Subtitle C cap design (EPA, 1991b) includes the following components (from top to bottom):

- 6 inches of vegetative cover soil
- 18 inches of cover soil
- Filter layer
- 12-inch-thick drainage layer

- 20-mil geomembrane
- 24 inches of low-permeability compacted clay layer (CCL)

A RCRA equivalent cover is allowed to substitute for the standard RCRA cap design if it meets or exceeds the performance of the original design. A RCRA equivalent cap is proposed for this site. WESTON submitted an equivalent cover design to the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) in June 2006 (WESTON, 2006c). The equivalent cover designs were evaluated for their performance in regard to minimizing percolation and providing a low permeability layer, withstanding potential earthquake forces, and possessing long-term durability.

The proposed equivalent cover design document incorporates geosynthetic materials that have been developed and refined over the past 10 to 15 years. The materials that will be incorporated in the equivalent cover have been developed and tested by manufacturers, studied and evaluated by academicians, and reviewed and approved by regulators across the United States. Use of these geosynthetic materials will provide greater protection of the environment and reduce construction time and cost.

The proposed equivalent cap design includes a Geosynthetic Clay Liner (GCL) to replace the original RCRA standard CCL. GCLs offer many advantages over CCLs. These include better performance under wetting and drying cycles, greater tolerance for total and differential settlement, easier placement, more rapid installation, reduction in air pollution during installation, less complex oversight required, and less dependence on weather during installation. GCLs are also less expensive to install. GCL-based cover systems have been successfully installed throughout the United States and can likewise be successfully installed at Mare Island IA-H1 to provide long-term protection of the environment (WESTON, 2006a).

The proposed design for the RCRA regulated units cap shown in Figure 8-2 consists of the following components (from top to bottom):

- 6 inches of vegetative cover soil
- 18 of cover soil
- Single-sided geocomposite drainage layer
- 60-mil geomembrane

- Geotextile-encased GCL
- Doublesided, nonwoven geotextile (gas venting layer)
- 24 inches of foundation material

8.2.1.2.2 Non-RCRA Hazardous Waste Cap

The non-RCRA multilayer cap (non-RCRA hazardous waste cap) is specifically designed to reduce infiltration and meets the minimum design requirements of CCR Title 27, Chapter 3, Subchapter 5, Article 2, Section 21090 performance standards and minimum design requirements for a final landfill cover system. The sequence of layers in a typical multilayer cap consists of, from the surface down, an erosion-resistant layer, a low-hydraulic conductivity layer, and a foundation layer.

The erosion-resistant layer, usually consisting of soil, supports vegetation and is typically at least 12 inches thick (CCR Title 27, Section 21090).

The low-hydraulic conductivity layer, typically consisting of compacted clay, is at least 12 inches thick (CCR Title 27, Section 21090) and functions to reduce infiltration as well as to control upward movement of landfill gases. The layer must meet minimum acceptable permeability requirements of 1×10^{-6} cm/s or be equal to the hydraulic conductivity of the underlying natural geologic material, whichever is less.

The foundation layer consists of a minimum 24-inch layer of compacted soil or waste materials, if suitable, to support the low-hydraulic and erosion-resistant layers (CCR Title 27, Section 21090).

The proposed design for the non-RCRA hazardous waste cap within the Containment Area, shown in Figure 8-3, consists of the following components (from top to bottom):

- 6 inches of vegetative cover soil
- 18 inches of cover soil
- Single-sided geocomposite drainage layer
- 60-mil geomembrane
- Doublesided, nonwoven geotextile at high points (gas collection layer)

- 24 inches of foundation material

The non-RCRA hazardous waste cap will cover Wetland X and other small wetland areas within the Containment Area. These wetlands consist of 2.0 acres of pickleweed, 0.5 acres of seasonally ponded water, and 4.7 acres of low-value, disturbed seasonal wetlands for a total wetland area of 7.2 acres. An area of 6.7 acres of higher value pickleweed marsh and 1.5 acres of seasonal ponded wetlands (total of 8.2 acres) will be created in the Upland Areas of IA-H1 to offset the wetland impacts within the Containment Area. The created wetlands will triple the amount of salt marsh harvest mouse habitat and increase the open water habitat area for migratory birds. The proposed upland wetland creation will also connect existing isolated wetlands. The planned wetland creation areas are currently uplands located mostly in the Demolition Debris and Sanitary Sewage Treatment Plant Subareas of IA-H1. The excavation of soil containing elevated levels of contaminants (hot spots) and non-contaminated overburden soil down to the target wetland creation elevations will remove the most significant and consequential contamination present in these areas. Excavated hot spot soil will be consolidated within the Containment Area prior to implementation of the cover. In 2005, a Time Critical Removal Action performed, by the Navy, at the Mare Island Marine Corps Firing Range produced 37,270 cubic yards of material that was similarly or less contaminated than the materials already in the IA-H1 Containment Area. This material was stockpiled in the Containment Area. This material and/or similar material from Mare Island will be used to provide a base upon which to build a non-RCRA hazardous waste cap. Sampling and analysis will be performed to ensure that the created wetland near-surface soil meets the risk-based criteria. Residual risk will be managed by institutional controls (land use restrictions and an operation and maintenance plan) to ensure future site activities do not destroy the created wetlands or create an exposure pathway for potential ecological or human receptors to contaminated soils at depths greater than the target exposure depths.

The overall goal of wetland mitigation is to replace lost wetland functions and values, as well as to create functional habitat for a variety of wildlife species, including the salt marsh harvest mouse. The development of the new wetlands will take place concurrently with wetland impact activities. Monitoring to ensure the created wetland is developing appropriately is included in the Wetland Mitigation and Monitoring Plan (LSA Associates, Inc. [LSA], 2006b), included as an appendix to the Draft Final IA-H1 Remedial Design Plan (WESTON, 2006c). Once established,

the wetland will provide ongoing benefits. Appropriate protective measures will be implemented to minimize impacts on endangered species during construction of the cap in the Containment Area. These include appropriate trapping methods and passive relocation of salt marsh harvest mice. These provisions are included in the Endangered Species Consultation (also called Biological Opinion), issued by the United States Fish and Wildlife Service (USFWS, 2006). Vegetation will be cut or removed immediately after the final trapping interval to ensure the salt marsh harvest mice do not return to the area. The created wetlands will provide long-term better value wetlands to the area.

8.2.1.2.3 Institutional Controls

Land use and access restrictions will be implemented as part of Alternative 2A to protect human health and as required by regulation. Land use restrictions would be placed on the site as deed restrictions, such as prohibiting residences, schools, day care centers, or hospitals; prohibiting cap, wetland habitat, or soil disturbance without United States Department of the Navy (DON) and California Environmental Protection Agency approval; performance of quarterly visual surveys; and implementation of an education and awareness program. Restrictions will also be put in place to preclude any groundwater extraction for agricultural or residential use. Alternative 2A includes a 6-foot high chain link fence with three strands of barbed wire and signage around the entire Containment Area as shown in Figure 8-1.

The Biological Opinion (USFWS, 2006) stipulates that the Navy will place restrictive covenants or similar protective mechanisms to protect wetland creation areas and salt marsh harvest mouse habitat. Specifically, the Biological Opinion states:

“The Comprehensive Environmental Response, Compensation, and Liability Act or CERCLA Record of Decision obligates the Navy to impose environmentally protective land use restrictions across all of IA H1. During the Navy’s ownership of this property, the Navy shall actively manage the creation/restoration areas to the salt marsh harvest mouse. As described in the Project Description of this biological opinion, in the event the Navy considers conveyance of the property to non-Federal entities, the Navy shall impose land use restrictions to prohibit incompatible land uses that could cause future effects to salt marsh harvest mice. Those restrictions shall be placed in a recorded covenant or similar protective mechanism that will run

with the land and apply to successive owners of the property. The Navy will provide opportunity for comment to the specific land use restrictions during development of the Finding of Suitability to Transfer (FOST). The FOST summarizes the environmental conditions of the property and establishes specific notifications and restrictions to be included in the property deed. The Navy anticipates the FOST to be developed no earlier than 2008. The land use restrictions shall include a list of prohibited activities that are inconsistent with the protection and maintenance of the habitat areas for salt marsh harvest mice.”

A plan for initiating and implementing trapping or other appropriate controls for burrowing animals to protect the cap from damage, will be included in the design document.

8.2.1.2.4 Groundwater Containment

The Interim Remedial Action, completed in September 2004, includes a Containment Barrier, consisting of an approximately 7,300 linear feet low-permeability soil bentonite slurry wall and groundwater extraction trench that surround the Containment Area. The depth of the slurry wall ranges from 15 to 25 feet below ground surface (bgs) and extends at least 5 feet into a thick layer of natural clay. Figure 2-14 shows a typical cross-section of the Containment Barrier.

Groundwater is collected and pumped out of the Containment Area. This is accomplished by use of two groundwater extraction trench systems parallel to and just inside of the slurry wall, each equipped with a series of sumps and pneumatic pumps, and a forcemain, which transports the leachate to a collection system. The groundwater extraction trench is located approximately 20 feet from the inside of the slurry wall to provide optimal control of the groundwater mounding behind the slurry wall, while maintaining its structural integrity. The west trench is approximately 4,300 feet long and contains nine collection sumps. The east trench is 3,000 feet long and contains six collection sumps. Sumps are not more than 500 feet apart. They are connected with perforated high-density polyethylene (HDPE) pipe, sloped at a minimum of 1 percent towards the sumps. The HDPE pipe lies on a bed of 1 foot of washed drain rock and is covered by drain rock up to the historical high groundwater level. The washed drain rock is surrounded with a geotextile, and covered by native cuttings and ultimately will lie under a landfill cap. Groundwater collected in the eastern trench passes through an oil/water separator

before combining with groundwater from the western trench. The combined groundwater and leachate is sampled and analyzed to verify compliance with the discharge requirements of the Vallejo Sanitary and Flood Control District (VSFCD) sanitary sewer system, where it undergoes further treatment. The combined groundwater and leachate will also be sampled and analyzed for contaminants consistent with the groundwater monitoring program required for the Containment Area.

It is anticipated that the groundwater mound in the Containment Area could be reduced to equilibrium levels in 2 to 5 years. Groundwater levels in wells outside the Containment Area and piezometers inside the Containment Barrier will be monitored to verify that levels outside the Containment Barrier are higher than the levels along the groundwater extraction trench, resulting in an inward hydraulic gradient. Extraction of groundwater will continue as necessary to maintain this inward gradient. Groundwater monitoring will also be performed in accordance with the post-closure sampling approach as described in the following section.

8.2.1.2.5 Groundwater Monitoring

A groundwater monitoring program is in place and will be revised upon application of the final cap and closure of the RCRA Landfill. The RCRA unit of the landfill is currently under interim status and subject to CCR, Title 22, Article 6 requirements. The monitoring plan is designed to meet RCRA Interim Status Facility and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements. The plan includes a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples that represent background water quality and the quality of groundwater passing the point of compliance. Upon completion of the cap and closure of the RCRA Landfill, a post-closure sampling plan will be implemented. The post-closure sampling plan will be designed to evaluate groundwater quality and to determine if the remedy is working adequately.

8.2.1.2.6 Gas Collection, Venting and Monitoring

A passive gas collection and venting system will be included in the RCRA and non-RCRA portions of the Containment Area cap. Gas concentrations will be monitored periodically, and a

corrective action program will be implemented should action levels be exceeded. Based on soil gas data collected during the investigation phase, a limited volume of methane gas is currently being generated. Based on limited sampling data (10 soil gas borings), it has been observed that landfill gas is being generated primarily within the RCRA Landfill portion of the Containment Area, and little is being generated within the remainder of the Containment Area (WESTON, 2005a). The non-methane organic compounds (NMOCs) identified during soil gas sampling and analysis at IA-H1 fall into three major groups: halogenated solvents, petroleum fuel constituents, and ketones (including alcohols and oxygen-containing compounds). The presence of these classes of chemicals is consistent with the subsurface materials at IA-H1, such as solvent-laden rags and waste petroleum products. Levels of NMOCs typically produced at a municipal landfill are 0.01 to 0.6 percent, according to the Agency for Toxic Substances and Disease Registry (ATSDR), *Landfill Gas Primer, An Overview for Environmental Health Professionals* (ATSDR, 2001); in the RCRA-regulated units, the NMOC levels were 0.0092 percent, and outside the RCRA-regulated units, the NMOC levels were 0.000025 percent. Methane gas production within the RCRA Landfill is consistent with methane production at a typical municipal landfill. Methane production in a typical municipal landfill ranges from 45 to 60 percent. Methane in the RCRA-regulated units ranged from 25 to 38 percent, and levels outside the RCRA-regulated units ranged from 0.0064 to 2.9 percent. The results and differences in soil gas generation from the RCRA-regulated units to the remainder of the Containment Area will be considered in the design document to appropriately design gas collection, venting, and monitoring. Gas generation will be included in the monitoring program once the remedy is applied. These results will be verified after implementation of the remedy.

8.2.1.3 Alternative 2B—RCRA Multilayer Cap, Institutional Controls, Groundwater Containment, and Gas Monitoring

Alternative 2B consists of land use and access restrictions; a RCRA Subtitle C equivalent multilayer cap (with surface drainage and erosion controls) over the entire Containment Area, with gas venting; a Containment Barrier; an extraction trench for groundwater containment; and periodic gas monitoring. A RCRA multilayer cap will be implemented under this alternative to isolate landfill refuse, eliminate direct contact of surface soil, reduce erosion, reduce surface soil contaminant migration, and limit surface water infiltration. This alternative is identical to

Alternative 2A, except that it extends the RCRA Subtitle C equivalent cap (described in Section 8.2.1.2.1) over the entire Containment Area as shown in Figure 8-4. This alternative also includes a 6-foot chain-link exclusionary fence surrounding the entire Containment Area, also shown in Figure 8-4.

8.2.1.4 Alternative 3—Removal and Disposal

Alternative 3 consists of complete removal of the RCRA/Facility Landfill and contaminated areas within the Containment Barrier and disposal in appropriate off-site hazardous waste or non-hazardous waste landfills. The major components of this alternative include the following:

- Mechanical excavation of contaminated soil, replacement with backfill to a sufficient grade using clean fill, and surface replacement
- Off-site disposal of contaminated soil and landfill refuse
- Engineering control measures to prevent airborne dust emissions from the site and to control surface erosion
- Safety procedures for identification and handling potential MEC and radiological material

Due to the potential for MEC and radiological items to be inadvertently transported off-site with contaminated soil and debris, appropriate safeguards (e.g. mechanically screening soil and limiting excavation “lifts” to 1 foot to allow pre-excavation radiological surveys) would likely be required. This alternative would also require extensive odor and dust suppression, and a traffic control plan to manage up to 100 trucks per day during the construction season for a period of 2 to 3 years, to transport waste off-site.

8.2.2 Upland Areas Outside The Containment Barrier Alternatives

Five remedial alternatives were assembled for the Upland Areas based on process options remaining from the technology screening process and site-specific conditions. The alternatives assembled for the Upland Areas are as follows:

- Alternative 1—No Action
- Alternative 2—Institutional Controls, Hot Spot Removal (Hazard Quotient [HQ] = 10), Groundwater Monitoring, and 2-Foot Soil Cover

- Alternative 3—Institutional Controls, Hot Spot Removal (HQ = 5), Groundwater Monitoring, and 2-Foot Soil Cover
- Alternative 4—Institutional Controls, Hot Spot Removal (HQ = 3), Groundwater Monitoring, and 2-Foot Soil Cover
- Alternative 5—Institutional Controls, Debris Excavation, and Groundwater Monitoring

8.2.2.1 Alternative 1—No Action

CERCLA requires the “No Action” alternative to be carried forward to the detailed analysis phase in order to provide a baseline comparison with the other alternatives. The “No Action” alternative implies that no remedial action would be undertaken within the Upland Areas of IA-H1.

8.2.2.2 Alternatives 2, 3, and 4—Hot Spot Removal (HQ=10, 5, and 3), Wetland Mitigation, Groundwater Monitoring, 2-Foot Soil Cover, and Institutional Controls

8.2.2.2.1 Institutional Controls

Land use restrictions will be placed on the IA-H1 property to prohibit the development of the land for unauthorized uses. Per the Mare Island Final Reuse Plan, future land use at IA-H1 includes recreational use and open space (City of Vallejo, California, 1994). The following land use restrictions will be placed on the site as deed restrictions:

- Future reuse of the property will prohibit residences, schools, daycare centers, or hospitals
- None of the following activities will be conducted unless the DTSC gives approval:
 - Covering or disturbing of groundwater wells in a manner that restricts access to groundwater wells
 - Alteration of groundwater conditions through activities such as groundwater pumping
 - No soil/sediment disturbing activities by the public will be permitted
 - No disturbance or destruction of wetland mitigation areas will be permitted
- Education and awareness programs will be implemented in the local community

- Construction of buildings or any other structures
- Grazing and agricultural activities of any type
- Altering the surface or general topography of the property, including building roads, paving, or otherwise covering the property.

Confirmation that the land use restrictions are maintained will be monitored visually during quarterly site inspections. During the inspections, the site will be assessed as to whether the land use restrictions have been violated. The area will be inspected quarterly to verify that no buildings or structures have been built at the site, no unauthorized wells have been installed, all groundwater wells are locked and in good condition, and that there have been no excavations or other subsurface activities at the site.

The DON's intention is to pursue title transfer of IA-H1 to an interested party or parties, including reversion to the State. Prior to a title transfer, the monitoring and enforcement of land use restrictions and institutional controls specified in the Remedial Action Plan (RAP)/Record of Decision (ROD)/RCRA Closure Plan will be incorporated into the Post-Closure/Post-Remedy Operations and Maintenance (O&M) Plan. This work will be performed by WESTON in accordance with the existing Environmental Services Cooperative Agreement. In the event all or a portion of IA-H1 are transferred or leased, the deed or Finding of Suitability to Lease will incorporate applicable land use restrictions and institutional controls.

8.2.2.2.2 Hot Spot Removal

Upland Areas Alternatives 2, 3 and 4 differ only in the amount of soil removed. The amount of material to be removed under each alternative differs in the level of ecological HQ applied to determine hot spots, with Alternative 1 having no hot spots removed to Alternative 5, which requires removing the entire debris area. Alternatives 2 through 4 include excavation of hot spot areas within the Upland Areas that exceed a human health cancer risk estimate of 1×10^{-5} , a human health HI of 1 for non-cancer adverse health effects, threats to groundwater, locations exhibiting visible oil or free product, and areas presenting an ecological risk based on the high Toxicity Reference Value (TRV) with a HQ of 10, 5, and 3, respectively. Alternative 5 requires the removal of all the Upland Areas, which would include all hot spots identified in the previous alternatives.

Table 8-1 presents a summary of the identification of hot spot areas based on different levels of ecological HQs. Figure 8-5 shows the hot spots for Alternatives 2 through 4. As each hot spot level subsequently requires removal of more material than the previous alternative, Figure 8-5 shows the hot spots building upon the previous alternative. Therefore, the hot spots for Alternative 3 include all the hot spots from Alternative 2 with additional material removed for the lower ecological HQ applied for Alternative 3; the hot spots for Alternative 4 include those from Alternative 3 with additional material removed for the application of the lower ecological HQ in Alternative 4.

All chemical concentrations from sample analyses were compared to the hot spot criteria developed for each exposure depth. A sample location was retained and included in the alternative if the chemical concentration of at least one risk driver (arsenic, total polychlorinated biphenyls [PCBs], and benzo[a]pyrene for human health; and copper, lead, selenium, zinc, total PCBs, and total dichlorodiphenyltrichloroethanes [DDTs] for ecological receptors) exceeded the criteria; if free product was observed at the location; if a chemical concentration presented a threat to groundwater; and/or if a chemical outlier presented a risk.

For example, the hot spot criteria for Alternative 4 were developed as follows. This alternative includes excavation of hot spot areas within the Upland Areas that exceed a human health cancer risk estimate of 1×10^{-5} a human health HI of 1 for noncancer adverse health effects, threats to groundwater, locations exhibiting visible oil or free product, and areas presenting an ecological risk based on the high TRV with a HQ of 3. A single set of comparison criteria are used for remediation in the upland habitat. The criteria are based on a tiered process of first comparing values of individual ecological receptors, then comparing the selected value to human health and threat to groundwater values, and finally comparing the new selected value to a statistical value for ambient/background. The “average threshold” ecological risk-based average values by chemical for the upland habitat are the lowest value across all receptors with the high TRV HQ 3 for the western meadowlark, California vole, ornate shrew, gray fox and northern harrier. For each chemical, the lowest number among the ecological average threshold, human health, and threat to groundwater criteria is compared to the 95th percentile of the ambient/background dataset, and the higher of the two numbers is selected. This final value was compared to the existing concentration results at individual locations to identify hot spots for excavation and will

be compared to the subsequent confirmation sample results to determine if further excavation is required. The subsequent placement of clean fill (a minimum of 2 feet) will occur over the entire upland habitat and is not dependant on residual concentrations.

The hot spot extent of contamination at a single, isolated sample point was conservatively estimated as a 50 by 50 foot area. Other hot spot boundaries were determined as the mid-point distance between a sample location that exceeded hot spot criteria and one in which chemical concentrations were below hot spot criteria. The depth of contamination for areas presenting an ecological risk was estimated at 2 feet bgs (the assumed exposure depth for ecological receptors). The depth of contamination for areas exhibiting free product was estimated at the lowest depth where free product was observed as described on the boring logs. The depth of contamination in areas presenting a human health risk in subsurface soils was estimated at approximately 1 foot deeper than the contaminated sample depth or at 10 feet bgs (the maximum exposure depth for human receptors), whichever is shallower. For areas exhibiting free product, an investigation of the extent of the oil/product would be conducted during excavation of these free product hot spot areas in order to correctly delineate the presence of oil/free product and refine the area and volume of contamination.

Confirmation samples will be collected from each 50 foot by 50 foot excavation area after soil removal and prior to backfilling. Samples will be analyzed for all risk drivers within IA-H1. The number of samples and specific sampling details will be prepared during the design phase and included in the Remedial Design Plan. In the event that contaminant concentrations at the base of an excavation exceed shallow cleanup criteria, the Navy will immediately notify DTSC and obtain from DTSC timely direction regarding the possible need for further excavation, based on threat to human health or the environment, or completion of hot spot excavation. The hot spot areas will then be backfilled to existing grade with soil from a suitable borrow source. The excavated soil will be consolidated on site within the Containment Area.

Soil will be removed with a hydraulic excavator and loaded into an off-road dump truck for transport to the Containment Area. The soil will be spread in 1 foot lifts and compacted using a large sheepsfoot compactor. Borrow soil used for backfilling the excavations will be similarly loaded, transported to the excavation site, spread, and compacted. The time to complete this task

is estimated at approximately 2 months. The following summarizes the volumes of soil to be removed under each alternative:

- Alternative 1—No Action; no soil will be excavated
- Alternative 2—Hot Spot Removal (HQ = 10); 45,755 cubic yards will be excavated
- Alternative 3—Hot Spot Removal (HQ = 5); 46,325 cubic yards will be excavated
- Alternative 4—Hot Spot Removal (HQ = 3); 54,765 cubic yards will be excavated
- Alternative 5—Total Debris Removal; 453,850 cubic yards will be excavated

8.2.2.2.3 Groundwater Monitoring

Groundwater monitoring in the SWBZ will be conducted at the margins of the Upland Areas near the Non-Tidal Wetland Areas. Migration of shallow groundwater to the Non-Tidal Wetland Areas is a potential concern. Implementation of a hot spot removal option should decrease the potential for contamination to move into the groundwater. The groundwater quality will be evaluated to ensure groundwater from the Upland Areas is not impacting the Non-Tidal Wetland Areas. Monitoring wells will be installed in appropriate locations at the margins of the Upland Areas. Groundwater will be monitored for COCs for a planned 30 years. During the 5-year review, if the wells show that contaminants are not moving into the wetlands, the monitoring requirement will be re-evaluated. Continued monitoring, if required, will be re-evaluated during the 5-year review.

8.2.2.2.4 2-Foot Soil Cover

The 2-foot soil cover involves placement of a minimum of a 2 feet deep soil cover over all Upland Areas, including all hot spot areas that have been refilled to their original levels. Upland Areas include the Demolition Debris Subarea, Northwest Dump Road Subarea, Fire-Fighting Training Subarea, Solid Waste Disposal/Lead Oxide Storage and Disposal Area, and Pond 1. The cover soil is “clean” soil and is tested to ensure that it meets acceptable standards. Because the cover soil contains less arsenic than the ambient/background Mare Island levels, the risk posed by areas containing the 2-foot soil cover will be less than that in the remainder of Mare Island ambient/background levels. The Remedial Design Plan describes the methods to ensure that cover soil does not mix with the underlying soil and that the specified amount of cover is

applied. The soil cover will be graded and hydroseeded to provide an adequate base for vegetative growth, which will have the added benefit of reducing particulate transport to the low-lying wetland areas of IA-H1. The hydroseeding and resultant plant growth will help to reduce any soil erosion.

The principle causes of erosion are rainfall and runoff. The resulting erosion can be estimated using the Universal Soil Loss Equation (USLE), which was developed to estimate long-term average annual soil loss. The factors used in the USLE include soil erodibility, slope length and steepness (LS), and cover management practices. A conservative LS factor of 0.66 was chosen based on a 150 foot long slope at 5 percent, which resulted in a calculated soil loss value of 0.03 tons per acre per year, which is far less than the allowable standard for adequate erosion control of 2 tons per acre per year. The 2-foot soil cover will also provide a barrier for any MEC materials or radiological items (if present) and block current ecological receptors from any remaining contamination. The total *in-situ* volume of the soil cover is estimated at 98,740 cubic yards. The area of the soil cover is 1,553,265 square feet.

8.2.2.2.5 Wetland Mitigation

Wetland mitigation is related to the Containment Area alternatives; however, the Upland Areas will be used to create the new wetlands. Wetland mitigation includes creation of approximately 8.2 acres of pickleweed/seasonally ponded wetland areas in the northwest upland portion of IA-H1 to compensate for the loss of existing degraded wetlands habitat covered by the Containment Area cap. The Wetland Creation Areas 1 through 5, depicted in Figure 8-5, will be graded to appropriate elevations (approximately 8 feet above mean sea level [amsl]) to allow for soil saturation and/or inundation that resemble the current hydrological regime of the adjacent existing wetlands. Achieving these hydrological conditions will promote the establishment of pickleweed marsh vegetation, which is preferred by the salt marsh harvest mouse, a federal and state endangered species. See the Containment Area discussion of wetland mitigation (Section 8.2.1.2.2) for further information.

8.2.2.2.6 Green Sand Excavation in Northwest Dump Road Subarea

A Green Sand Area is visible on the soil surface within the Northwest Dump Road Subarea (Figure 8-5). The approximate dimensions of the Green Sand Area are 100 feet by 100 feet. The surface soil and visible green sand will be removed and samples taken and analyzed prior to backfilling. An estimated 185 cubic yards of soil and green sand will require excavation and disposal. This area will be filled to grade and receive an additional two foot cover following excavation activities.

8.2.2.2.7 Asbestos Soil Cover in Pond 1

Small amounts of asbestos-containing materials are visible within portions of Dredge Pond 1 inside IA-H1. The 2-foot soil cover described in Section 8.2.2.2.4 will provide an effective barrier against potential exposure to these materials.

8.2.2.3 Alternative 5—Debris Excavation and Groundwater Monitoring

8.2.2.3.1 Upland Debris Excavation

Alternative 5 includes excavation of all upland fill material within the Demolition Debris Subarea, Northwest Dump Road Subarea, Fire-Fighting Training Subarea, Solid Waste Disposal/Lead Oxide Storage and Disposal Subarea, and the Upland Areas of the West Subarea (Pond 1). Figure 8-6 shows the excavation boundaries for the entire fill area. Because the hot spot areas presenting an ecological risk based on the high TRV with an HQ of 1 are widespread throughout the Upland Areas, this alternative includes excavation of all fill areas rather than just hot spot locations (Figure 8-6).

The Demolition Debris Subarea, excluding the proposed mitigated wetland area within this subarea, is approximately 5.6 acres. The depth of the debris ranges from 2 to 14 feet bgs. The estimated *in-situ* quantity of debris and fill material at the Demolition Debris Subarea is 63,230 cubic yards.

The Fire-Fighting Training Subarea, excluding the existing and proposed wetland areas within this subarea, is approximately 5.7 acres. The depth of the debris ranges from 2 to 8 feet bgs. The

estimated *in-situ* quantity of debris and fill material at the Fire-Fighting Training Subarea is 45,985 cubic yards.

The Northwest Dump Road Subarea, excluding the existing and proposed wetland areas within this subarea, is approximately 8.8 acres. The depth of the debris ranges from 10 to 16 feet bgs. The estimated *in-situ* quantity of debris and fill material at the Northwest Dump Road Subarea is 184,580 cubic yards.

The Upland Areas within the West Subarea (Pond 1) comprise approximately 5.1 acres. The depth of the debris ranges from 5 to 7 feet bgs. The estimated *in-situ* quantity of debris and fill material at the Upland Areas within the West Subarea (Pond 1) is 49,370 cubic yards.

The Solid Waste Disposal/Lead Oxide Storage and Disposal Subarea is approximately 8.6 acres. The depth of the debris ranges from 6 to 12 feet bgs. The estimated *in-situ* quantity of debris and fill material at the Solid Waste Disposal/Lead Oxide Storage and Disposal Subarea is 110,665 cubic yards. A portion of the fill area may be salvaged from the clean fill placed during the removal action at Installation Restoration (IR) Area 16.

As shown in Table 8-1, the total estimated *in-situ* volume of the debris within the Upland Areas is 453,850 cubic yards. The areas will be backfilled to a grade of about 8.5 to 9 feet amsl and the excavated soil will be disposed of within the Containment Area. All excavated areas will be graded and hydroseeded.

8.2.2.3.2 Groundwater Monitoring

The discussion in Section 8.2.2.2.3 applies to Upland Areas Alternative 5 in a limited manner. Because the debris will be fully removed, there will not be a continuing source of contamination. The only reason to monitor groundwater in this area is to monitor any contamination that is already in the groundwater.

8.2.3 Non-Tidal Wetland Areas Outside the Containment Barrier Alternatives

Five remedial alternatives were assembled for the Non-Tidal Wetland Areas based on process options remaining from the technology screening process and site-specific conditions. The alternatives assembled for the Non-Tidal Wetland Areas are as follows:

- Alternative 1—No Action
- Alternative 2—Institutional Controls, Hot Spot Removal (HQ = 10), and Monitoring
- Alternative 3—Institutional Controls, Hot Spot Removal (HQ = 5), and Monitoring
- Alternative 4—Institutional Controls, Hot Spot Removal (HQ = 3), and Monitoring
- Alternative 5—Institutional Controls, Hot Spot Removal (HQ = 1), and Monitoring

8.2.3.1 Alternative 1—No Action

CERCLA requires the “No Action” alternative to be carried forward to the detailed analysis phase in order to provide a baseline comparison with the other alternatives. The “No Action” alternative implies that no remedial action will be undertaken within the Non-Tidal Wetland Areas of IA-H1.

8.2.3.2 Alternatives 2, 3, 4, and 5—Institutional Controls, Hot Spot Removal (HQ=10, 5, 3, and 1), and Monitoring

8.2.3.2.1 Institutional Controls

The discussion in Section 8.2.2.2.1 applies equally to Non-Tidal Wetland Areas Alternatives 2 through 5.

8.2.3.2.2 Hot Spot Removal

Non-Tidal Wetland Areas Alternatives 2 through 5 include excavation of hot spot areas within the Non-Tidal Wetland Areas that exceed a human health cancer risk estimate of 1×10^{-5} , a human health HI of 1 for non-cancer adverse health effects, threats to groundwater, and areas presenting an ecological risk based on the high TRV with a HQ of 10, 5, 3, and 1, respectively. All chemical concentrations from sample results were compared to the hot spot criteria developed for each COC at differing HQs. A sample location was retained and included in the alternative if the chemical concentration of at least one risk driver (arsenic, total PCBs, and benzo[a]pyrene for

human health; and antimony, lead, selenium, and total PCBs for ecological receptors) exceeded the criteria; if a chemical concentration presented a threat to groundwater; and/or if a chemical outlier presented a risk.

Figure 8-7 shows the hot spots for the Non-Tidal Wetland Areas. Table 8-2 presents a summary of the identification of hot spot areas based on the aforementioned risk-based criteria. For example, the method for determining hot spots for Alternative 5 is as described below. This alternative includes excavation of hot spot areas within the Non-Tidal Wetland Areas including areas that exceed a human health cancer risk estimate of 1×10^{-5} , a human health HI of 1 for noncancer adverse health effects, threats to groundwater, and areas presenting an ecological risk based on the high TRV with a HQ of 1. Two sets of criteria are used for remediation in the non-tidal wetland habitats, the “average” and “upper” thresholds. Both sets of criteria are based on a tiered process of first comparing values protective of individual ecological receptors, then comparing the selected ecological value to human health and threat to groundwater values, and finally comparing the final selected value to a statistical value for ambient/background.

The two thresholds differ in that the average threshold includes the low TRV HQ of one for the salt marsh harvest mouse and the 95th percentile of the ambient/background dataset, whereas the upper threshold includes the high TRV HQ of one for salt marsh harvest mouse and the maximum value of the ambient/background dataset (with three exceptions).

The “average threshold” ecological risk-based average values by chemical for the non-tidal wetland are the lowest value across all receptors with the high TRV HQ of one for killdeer, mallard (breeding and non-breeding), great blue heron, the gray fox, and the northern harrier, and the low TRV HQ of one for salt marsh harvest mouse. For each chemical, the lowest number among the ecological average threshold, human health, and threat to groundwater criteria is compared to the 95th percentile of the ambient/background dataset, and the higher of the two numbers is selected as the average threshold. This final value will be compared to the 95UCL of the residual database that includes all sample locations still in place, the new confirmation samples, and the characterization samples for the fill material (which would replace those from excavated locations). If the 95UCL of the residual data exceeds the final average threshold criterion, then an iterative process of excluding individual locations and recalculating the 95UCL would occur until the revised 95UCL was below the average threshold. Then additional

excavation at those locations would occur, the subsequent confirmation samples be added to the residual database, and a new 95UCL would be calculated.

The “upper threshold” ecological risk-based values by chemical for the non-tidal wetland are the lowest value across all receptors with the high TRV HQ of one for killdeer, mallard (breeding and non-breeding), great blue heron, the gray fox, and the northern harrier, and the salt marsh harvest mouse. For each chemical, the lowest number among the ecological upper threshold, human health, and threat to groundwater criteria is compared to the maximum (99th percentile) of the ambient/background dataset, and the higher of the two numbers is selected.

This final upper threshold value will be compared to the existing concentration results at individual locations to identify hot spots for excavation and the subsequent confirmation sample results to determine if further excavation is needed there. Excavation at individual locations may also be needed to reduce the overall 95UCL of the residual data as described above.

For three chemicals (chromium, manganese, mercury), the high TRV HQ of one based ecological criterion for the most sensitive receptor was lower than the human health and threat to groundwater values, and was also lower than the 95th percentile and maximum ambient/background values. Additional evaluation of the relative concentrations and locations in the marsh for each sample was done for these chemicals as described below.

For chromium, the high TRV HQ of one value for killdeer (17.7 mg/kg) was the lowest value of the ecological, human health, and threat to groundwater criteria. The 95th percentile and maximum values of the ambient/background dataset for chromium are 140 and 148 mg/kg, respectively. Twenty-five samples have chromium concentrations above 148 mg/kg with a maximum of 257 mg/kg. Eight locations were identified as hot spots based on other chemicals (IR01HA036, IR01HA009, IR01HA013, IR16SS430, IR16SS424, IR01HA018, IR16SS406, and IR16SS435). All the other locations with concentrations above 148 mg/kg chromium located within 150 feet of an upland area or a proposed excavation area were included as hot spot areas to be excavated (IR16SS450, IR16SS407, IR16SS408, IR16SS451, IR16SS431, IR01HA003, IR01HA001, IR01HA014, IR01HA015, IR01HA008, IR01HA002, IR01HA004, IR01HA011, IR01HA012, IR01HA016, and IR02GB016).

For manganese and mercury, the maximum values from the ambient/background dataset were anomalously high at 13,559 and 69.7 mg/kg, respectively. Therefore, the 95th percentile ambient/background values (1,600 and 2 mg/kg, respectively) were used as the comparator. However, several wetland locations that had mercury or manganese concentrations greater than the 95th percentile ambient/background values were not proposed for excavation, because they were individual sample locations located at least 150 feet from an adjacent upland edge or an identified hot spot excavation area. The resource trustees identified these exceptions based on best professional judgment of the benefit of removing that isolated contamination compared with the impact of accessing and removing it. For manganese, six locations had manganese concentrations above 1,600 mg/kg with a maximum of 4,810 mg/kg. Three locations were identified as hot spots based on other chemicals (WETBSD050, IR01GB095 and WETBSD032), two were added as hot spots and are near an upland edge or other excavation area (WETASD012 and WETBSD033), and one isolated location will be left in place due to distance from an adjacent upland or a proposed excavation area (H-14 in Wetland D). For mercury, seven locations had concentrations exceeding 2 mg/kg with a maximum of 5.1 mg/kg. One location was identified as a hot spot based on other chemicals (WETBSD050), three were added as hot spots and were near an adjacent upland or a proposed excavation area (WETBSD053, WETBSD035, and WETBSD036), and two isolated locations will be left in place based on distance from an adjacent upland or a proposed excavation area (WETASD005 and WETBSD030). The hot spot distribution for Alternative 5 in wetland B (freshwater wetland) created an extensive mosaic that is shown in the figures as one continuous area. Flowcharts demonstrating the above hot spot excavation decision logic are shown in Figure 8-8.

Figure 8-7 presents the hot spot locations for these alternatives and demonstrates how each successive alternative builds upon and includes the areas from the previous alternative. The extent of contamination at a single isolated point area was conservatively estimated as a 50 by 50 foot area. Other areas were determined as a mid-point distance between a sample location greater than the hot spot criteria, and one in which chemical concentrations were below hot spot criteria. The depth of contamination for areas presenting an ecological risk was estimated at 2 feet bgs (the assumed exposure depth for ecological receptors). The depth of contamination for areas exhibiting free product was estimated at the lowest depth where free product was observed as described on the boring logs. The depth of contamination in areas presenting a human health risk

in subsurface soils was estimated at approximately 1 foot deeper than the contaminated sample depth or at 10 feet bgs (the maximum exposure depth for human receptors), whichever is shallower. The areas, depths, and volume of soil to be removed at each hot spot area are presented in Table 8-2.

Confirmation samples will be collected from each excavation area after soil removal and prior to backfilling. The number of samples and specific sampling details will be prepared during the design phase and included in the Remedial Design Plan. Samples will be analyzed for all risk drivers within IA-H1. The results of the confirmation sampling will be used to demonstrate that the Remedial Action Objectives have been met as described. The hot spot areas will be backfilled to existing grade with soil from a suitable borrow source. The excavated soil will be consolidated on site within the Containment Area. All excavated wetland areas will be restored to pre-existing conditions.

Soil will be removed with a hydraulic excavator and loaded into an off-road dump truck for transport to the Containment Area. The soil will be spread in 1 foot lifts and compacted using a large sheepsfoot compactor. Borrow soil used for backfilling the excavations will be similarly loaded, transported to the excavation site, spread, and compacted. Confirmation sampling will be completed from each 50 foot by 50 foot excavation area to ensure the COCs have been removed. Excavation will continue until the criteria set out in the Remedial Design Plan are met or excavation has reached 3 feet below target grade. In the event that contaminant concentrations at the base of an excavation exceed shallow cleanup criteria, the Navy will immediately notify DTSC and obtain from DTSC timely direction regarding the possible need for further excavation, based on threat to human health or the environment, or completion of hot spot excavation. Any excavation below target grade will be backfilled with the appropriate fill as outlined in the Wetland Mitigation Plan.

8.2.3.2.3 Monitoring

A monitoring program to show the performance of the remedial action will be developed as part of the remedial design. Summary reports will be prepared documenting the results of the monitoring program. Monitoring will document that the exposure risks to ecological receptors

remain limited or decrease over the long term. Monitoring programs will be evaluated for any changes required during the 5-year review.

9. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the results of the comparative analysis conducted to evaluate the relative advantages and disadvantages of each remedial alternative in relation to the nine evaluation criteria outlined in Health and Safety Code Section 25356.1(d), which requires that remedial action plans (RAPs) be based on the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121(b), as amended. A complete discussion of the evaluation of the alternatives for Investigation Area H1 (IA-H1) is presented in the IA-H1 Final Feasibility Study (FS) report (Weston Solutions, Inc. [WESTON], 2006a).

The nine criteria, as modified for the State of California, are summarized below.

THRESHOLD CRITERIA

1. ***Overall Protection of Human Health and the Environment*** — Addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
2. ***Compliance with State and Federal Applicable or Relevant and Appropriate Requirements (ARARs)*** — Addresses whether or not a remedy will meet all appropriate federal, state, and local environmental laws and regulations.

BALANCING CRITERIA

3. ***Long-term Effectiveness and Permanence*** — Refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met.
4. ***Reduction of Toxicity, Mobility, and Volume*** — Refers to the ability of a remedy to reduce the toxicity, mobility, and volume of the hazardous substances or constituents present at the site through treatment.

5. *Short-Term Effectiveness* — Addresses the period of time needed to complete the remedy, and any adverse impact on human health and the environment that may be posed during the construction and implementation period, until the cleanup standards are achieved.
6. *Implement ability* — Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to carry out a particular option.
7. *Cost* — Evaluates the estimated capital, operation, and maintenance costs of each alternative.

MODIFYING CRITERIA

8. *Regulatory Agency Acceptance* — Indicates whether, based on its review of the information, the applicable regulatory agencies would agree with the preferred alternative.
9. *Community Acceptance* — Indicates whether community concerns are addressed by the remedy, and whether or not the community has a preference for a remedy. In order for an alternative to be eligible for selection, it must meet the first two criteria described above, called "threshold criteria."

9.1 THRESHOLD CRITERIA

The Alternative 1 — “No Action” alternative for each area does not meet the threshold criteria of overall protection of human health and the environment and compliance with ARARs for the open space/recreational use scenario. The “No-Action” alternative will result in site conditions that are controlled only by current land use practices. Without additional controls, land use could change giving rise to the unacceptable exposure of contaminants to human and ecological receptors.

Because Alternative 1 does not meet the threshold criteria, this alternative is not eligible for selection as it does not meet the Remedial Action Objectives (RAOs) and therefore is not included in further analysis. According to the NCP, however, the “No-Action” alternative provides a basis for comparison against other alternatives. Except for the “No Action” alternatives, all other alternatives for the Containment Area, Upland Areas, and Non-Tidal Wetland Areas, meet the threshold criteria for protection of human and ecological health and are compliant with ARARs.

9.2 BALANCING CRITERIA

The following five criteria are used for comparative analysis of remedial alternatives and are discussed in the following sections:

- Long-Term Effectiveness and Permanence
- Reduction in Toxicity, Mobility, and Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

9.2.1 Long-Term Effectiveness and Permanence

Containment Area Alternatives

The remedial alternatives for the Containment Area were described in Section 8.2.1. Alternatives 2A, 2B and 3, provide long-term effectiveness and permanence; however, Alternatives 2A and 2B depend on long-term maintenance of the cap. Alternative 3 will depend on the long-term management of an off-site waste disposal facility. Alternative 2B provides slightly greater protection from groundwater infiltration compared with Alternative 2A, since the geosynthetic clay liner (GCL) would be extended under the geomembrane liner over the entire Containment Area, not just the required Resource Conservation and Recovery Act (RCRA)-regulated areas. However, according to EPA guidance, all liners leak to a small degree, a 1 millimeter (mm) infiltration across the liner would be about 0.145 gallons per minute (gpm) (200 gallons per day, or 3 gallons per acre per day) for the entire 72-acre Containment Area. A GCL would presumably reduce this small leakage even further, but since the entire area is surrounded by the slurry wall/extraction trench, a very small incremental leakage rate for Alternative 2A versus Alternative 2B is negligible. Even without a cap, the combined flowrate from the extraction system averaged just over 5 gpm during the recent dry-season months.

Groundwater infiltration is related to landfill gas generation and migration of soil contaminants. Since there is little or no landfill gas generation occurring outside the RCRA-regulated units, and

The groundwater is totally contained by the surrounding slurry wall and extraction trench, there is limited difference between Alternatives 2A and 2B in terms of long-term effectiveness and permanence.

Upland Areas Alternatives

The remedial alternatives for the Upland Areas were described in Section 8.2.2. Alternatives 2, 3, 4, and 5 provide long-term effectiveness and permanence. Alternatives 2, 3, and 4 are roughly equivalent, as all are protective of human health and groundwater, but Alternative 5 provides slightly more effectiveness in reducing the overall risks. Additional reduction in the overall ecological hazard quotient (HQ) by Alternative 4 is realized compared with Alternatives 2 and 3. Each remedy meets the target of hazard index (HI) values of less than 1 for human non-cancer effects. Alternative 5 will provide for the removal of more contaminants to the Containment Area with a slight incremental additional lowering of the human health and ecological risks. For the underlying materials, however, the overall risk for Alternatives 2 through 4 will be lower due to the application of a high quality 2-foot soil cover (lower ambient/background risk). Arsenic (the overwhelming residual risk driver), for example, in the baseline risk assessment for recreational users yielded a cancer risk of 6.1×10^{-5} , and the post remedy risk of 1.7×10^{-5} including the high quality fill material for the 2-foot soil cover for the recreational user. This is an improvement on what could be expected from ambient/background risk levels at the site. Table 9-1 shows a comparison of risk between baseline and residual risk with the 2-foot soil cover for a recreational user and construction worker. There is a 62 and 63 percent reduction in risk, respectively, with the greatest reduction in risk coming from arsenic reductions.

Non-Tidal Wetland Areas Alternatives

The remedial alternatives for the Non-Tidal Wetland Areas were described in Section 8.2.3. Alternative 5 (HQ=1) provides the most long-term effectiveness and permanence, removes the most material, and is more protective of the salt marsh harvest mouse. Since the HQ of 1 for Alternative 5 is equivalent to the “no adverse effect” level, this alternative was considered to be the only option that met the intent of the State ARARs concerning the salt marsh harvest mouse as a fully protected species.

9.2.2 Reduction in Toxicity, Mobility, or Volume

Containment Area Alternatives

None of the alternatives provide for the reduction in toxicity or volume through treatment. Alternatives 2A and 2B provide reduction in mobility on-site through containing the refuse and contaminated materials with a cap (eliminating surface exposure) and preventing contaminated groundwater from moving off site through the Containment Barrier. Alternative 3, while requiring the removal of material from the site, does not provide reduction in toxicity, or mobility through treatment.

Upland Areas Alternatives

None of the alternatives provide for the reduction in toxicity or volume through treatment. Mobility will be reduced by removing soil hot spots and consolidating them within the Containment Area cap, rather than through treatment.

Non-Tidal Wetland Areas Alternatives

None of the alternatives provide for the reduction in toxicity or volume through treatment. Mobility will be reduced by removing soil hot spots and consolidating them within the Containment Area cap, rather than through treatment.

9.2.3 Short-Term Effectiveness

Containment Area Alternatives

Alternatives 2A and 2B pose fewer risks to workers and the community because of the increased risks with excavation and transporting waste in Alternative 3. Approximately 50,000 truckloads of waste would be moved off site to another facility under Alternative 3, requiring up to 100 trucks per day during the construction season over a 2 to 3 year period.

Alternatives 2A and 2B can be implemented faster than Alternative 3. Alternative 3 will take substantially more time to complete (approximately 2 to 3 years), generates truck traffic concerns, has more potential to generate odor, dust, and particulates, and is more likely to expose workers, and potentially the public, to hazardous materials and radiological items, and munitions or explosives of concern (MEC), if present.

Upland Areas Alternatives

Alternatives 2, 3, and 4 have similar short-term effects, with Alternative 2 having less impact due to the smaller volume of material removed. Alternative 5 has more severe short-term impacts due to the large amount of material required to be excavated.

Non-Tidal Wetland Areas Alternatives

Hot spot removal in Alternatives 2, 3, 4, and 5 have relatively minor short-term impacts. Alternative 5 requires the removal of more material than the other alternatives but all alternatives remove relatively small hot spots within the wetlands that should recover relatively quickly.

9.2.4 Implementability

Containment Area Alternatives

Alternatives 2A and 2B are readily implementable with standard technologies. Alternative 3 is much more difficult to implement, as it requires many more resources, off-site disposal contracts, and significant on- and off-site hazardous waste handling and off-site transportation impacts. Screening for MEC and radiological items prior to loading would be difficult or impractical due to the large quantities of debris intermixed with clay used as a cover.

Upland Areas Alternatives

Alternative 2 is slightly more easily implemented than Alternative 3, which is slightly more implementable than Alternative 4 due to the smaller amount of material removed, but all are implementable. Alternative 5 is much more difficult to implement due to the large amount of material required to be excavated and consolidated within the Containment Area. Also, the settlement within the Containment Area would be greater with the large volume and weight of soil to be excavated and consolidated.

Non-Tidal Wetland Areas Alternatives

Alternative 5 is the most difficult to implement due to the amount of material removed; however all alternatives are implementable with slightly more material being removed for each successive alternative.

9.2.5 Cost

Containment Area Alternatives

The total cost for Alternative 2A, including operations and maintenance (O&M), and regulatory oversight cost is \$31,300,000. The cost for implementing Alternative 2B is \$ 34,000,000; \$2,700,000 greater than Alternative 2A. Approximately \$2,390,000 of the total has already been spent to install the Containment Barrier. The costs for implementing Alternative 3 are significantly higher, with a total of \$218,201,000. There will be less need for O&M with Alternative 3; however, the implementation cost is extremely high. Costs for Alternatives 2A and 2B include long-term operations and monitoring for the cap and monitoring for the upland groundwater and created wetlands. RCRA regulations require that cost estimates include a minimum of 30 years post-closure care. The discount rate was 4 percent.

Upland Areas Alternatives

The total cost for Alternative 2 is \$2,976,000; the cost for Alternative 3 is slightly higher, for a total of \$3,006,000; the cost for Alternative 4 is slightly higher than for Alternative 3, for a total of \$3,160,000. The cost for implementing Alternative 5 is over six times higher than the rest of the alternative costs for a total of \$19,181,000.

Non-Tidal Wetland Areas Alternatives

The total cost for Alternative 2 is \$104,000 and the cost to implement Alternatives 3 and 4 are \$141,000 and \$181,000, respectively. The cost for Alternative 5 is \$365,000.

9.3 MODIFYING CRITERIA

State and community acceptance criteria are used for comparative analysis of remedial alternatives as CERCLA-recognized modifying criteria. State and community acceptance, which cannot be fully evaluated until comments from the public are received, will be further evaluated after the public comment period.

9.4 RESULTS OF COMPARATIVE ANALYSIS

Results of the comparative analysis for each alternative are summarized in Tables 9-2, 9-3, and 9-4, for the Containment Area, Upland Areas, and Non-Tidal Wetland Areas, respectively.

Threshold criteria are shown with a “yes” or “no” indicating whether or not the alternative meets the required threshold. The remaining balancing criteria are ranked using a scale of one through five, with the grade of one indicating that an alternative meets a criterion best. The alternatives have been ranked for the threshold and balancing criteria. Alternative 1 for each of the areas provides a basis for comparison against other alternatives.

For the Containment Area, Table 9-2 shows that Alternatives 2A and 2B (capping) rate highest among the remaining acceptable alternatives. Alternative 2A is moderately less expensive than Alternative 2B, provides long-term protection of human health and the environment, and is much more practical to implement than Alternative 3.

For the Upland Areas, Table 9-3 shows that Alternatives 2, 3, and 4, while having the same overall rating, are roughly equivalent in overall effectiveness and have slight tradeoffs in implementability and cost. Alternative 5 provides long-term protection of human health and the environment but with many more short-term impacts, much higher costs, and a longer implementation time.

For the Non-Tidal Wetland Areas, Table 9-4 shows Alternative 5 as the best ranking alternative, and is fully protective of the endangered salt marsh harvest mouse.

10. STATUTORY DETERMINATIONS

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the United States Department of the Navy's (DON's) primary responsibility is to undertake remedial actions that achieve adequate protection of human health and the environment. Section 121 of CERCLA establishes several additional statutory requirements and preferences specifying that, when complete, the selected remedial action must comply with Applicable or Relevant and Appropriate Requirements (ARARs) established under federal and state laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and use permanent solutions and alternative treatment technologies to the maximum extent practicable. The statute also includes a preference for remedies that, as their principal element, permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste. The statute requires that periodic reviews be conducted at least every 5 years at sites where contamination is left in place.

The following sections discuss how the selected remedy meets these statutory requirements and preferences. Complete discussions are found in the Final Feasibility Study (FS) Report for Investigation Area H1 (IA-H1) (Weston Solutions, Inc. [WESTON], 2006a).

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Remedial Action Objectives (RAOs) for IA-H1 are concerned with limiting future contaminant migration and exposures to contaminated media. The selected remedy protects human health and the environment by preventing use of contaminated groundwater, preventing migration of contaminated groundwater, removing hot spot-contaminated soil and sediment, and containment. Restrictions will also be used during remediation to prevent disturbance of monitoring wells. Impacts to the Non-Tidal Wetland Areas will be mitigated by the creation of new higher value non-tidal wetlands. There are no short-term threats associated with the selected remedy that cannot be controlled. In addition, no adverse cross-media impacts are expected from the remedy.

10.2 COMPLIANCE WITH ARARS

The selected remedy will comply with the substantive portions of all ARARs. Section 121(e) of CERCLA, United States Code (U.S.C.) Section (§) 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site. Therefore, actions conducted entirely on site must meet only the substantive requirements of the ARARs. Any action conducted off site is subject to the full requirements of federal, state, and local regulations. The chemical-, location-, and action-specific ARARs for the selected remedy for IA-H1 are listed in Tables 10-1, 10-2, and 10-3, respectively, and are discussed below.

10.2.1 Chemical-Specific ARARs

The selected remedial action will be implemented to comply with chemical-specific ARARs. Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment. If a chemical has more than one remediation goal, the most stringent level has been identified as an ARAR for this remedial action.

Chemical-specific ARARs have been identified for groundwater and soil. Groundwater is a medium of concern at IA-H1, and although it is not a potential source of drinking water, it is of ecological concern. Soil at IA-H1 is also a medium of ecological concern.

10.2.1.1 Groundwater and Surface Water

The substantive provisions of the following requirements were identified as the most stringent of the potential federal and state groundwater ARARs for the remedial action at IA-H1:

- Resource Conservation and Recovery Act (RCRA) groundwater protection standards in California Code of Regulations (Cal. Code Regs.) Title 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e)
- Clean Water Act of 1977 (33 U.S.C., 26 § 1251-1387)

The most stringent of these requirements are the RCRA groundwater protection standards and Cal. Code Regs. Title 22, § 66264.94 requirements to restore affected groundwater to background conditions, if possible, or else attain the best water quality that is technically and

economically feasible. The DON has determined that the substantive provisions of Cal. Code Regs. Title 22, § 66264.94(a) (1), (a) (3), (c), (d), and (e) constitute relevant and appropriate federal requirements for groundwater. These provisions are considered a federal ARAR because this requirement was approved by the United States Environmental Protection Agency (EPA) in its 23 July, 1992, authorization of the state of California's RCRA program and is federally enforceable.

Under the Safe Drinking Water Act (SDWA) and RCRA, a significant issue in identifying ARARs for groundwater is whether the groundwater can be classified as a source of drinking water. The EPA groundwater policy set forth in the National Contingency Plan (NCP) preamble uses the system set out in the EPA Guidelines for Groundwater Classification. The three aquifers underlying IA-H1 were excepted from beneficial use characterization in a letter dated 17 March, 2004, from the California Environmental Protection Agency San Francisco Bay Regional Water Quality Control Board (Water Board) to the DON, based on the fact that the total dissolved solids (TDS) contained in the three aquifers (shallow, intermediate, and deep) exceed 3,000 milligrams per liter (mg/L). According to the Water Board Resolution No. 89-39, the groundwater from these aquifers cannot be a source of drinking water for a municipal or domestic water supply, therefore, Maximum Contaminant Levels (MCLs) are neither applicable nor relevant and appropriate and are not used to determine preliminary response action goals (EPA, 1986; 55 Fed. Reg. 8666, 8750–8754 [1990]).

RCRA Groundwater Protection Standards

Cal. Code Regs. Title 22, § 66264.94 describes how concentration limits for groundwater protection standards are set for RCRA-regulated units. This regulation provides that compounds must not exceed their background levels in groundwater or some higher concentration limit set as part of a corrective action program. A limit greater than background may be approved if the owner can demonstrate that it is not technologically or economically feasible to achieve the background value and that the constituent at levels below the corrective action program concentration limit will not pose a hazard to human health or the environment. RCRA groundwater protection standards are applicable only for regulated units managing hazardous wastes. These standards are applicable to the regulated RCRA interim status units at IA-H1.

An interim remedial action for groundwater containment was completed in 2005 and is described in Section 2.5.2. This groundwater containment action provides an alternative to numerical remediation goals.

Any potential contaminated groundwater discharges to surface water are eliminated from the Containment Area because the Containment Barrier has been installed and is operating. There are no known discharges of groundwater to surface water from areas outside the Containment Area. However, there may be limited hydraulic communication between the surface water and groundwater of San Pablo Bay and the non-tidal wetland surface water and groundwater within IA-H1 outside the Containment Area. Clean Water Act (CWA) statutory effluent treatment requirements for storm water discharges from small construction activity are potential federal ARARs. These requirements are specified in Section 402(p) (3) (A) of the CWA (42 U.S.C. § 1342[p] [3] [A]).

10.2.1.2 Soil and Sediment

Military Munitions Rule

The Military Munitions Rule describes the identification of hazardous waste munitions and treatment and storage requirements for hazardous waste munitions at C.F.R. Title 40, pt. 266, subpt. M. Only munitions debris has been found at the site; however, the potential for uncovering munitions exists during excavation activities. Therefore the Military Munitions Rule is a relevant and appropriate ARAR.

10.2.2 Location-Specific ARARs

The selected remedial action will be implemented to comply with location-specific ARARs, which are restrictions on the concentrations of hazardous substances or on activities solely because they are in specific locations such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

The substantive provisions of the following requirements were identified as the most stringent of the potential federal and state location-specific ARARs for the remedial action at IA-H1:

- 40 Code of Federal Regulation (C.F.R) § 6.302(a) (Executive Order No. 11990, Protection of Wetlands)
- 16 U.S.C. §§ 1531–1543 (Endangered Species Act [ESA])

- 16 U.S.C. §§ 1451–1464 (Coastal Zone Management Act [CZMA])
- 16 U.S.C. §§ 703–712 (Migratory Bird Treaty Act)
- California Fish and Game Code (Cal. Fish & Game Code) § 2080 (California ESA)

Wetlands

Jurisdictional wetlands exist at IA-H1. Title 40 C.F.R. § 6.302(c) requires that actions within wetlands be implemented to minimize the destruction, loss, or degradation of wetlands. The DON will take appropriate action during the remedial design and remedial action phase to minimize impact on wetlands.

Endangered Species

IA-H1 remedial actions might affect areas that support federal and California-listed endangered species or habitat. The salt marsh harvest mouse is an endangered species present at IA-H1. The ESA of 1973 (16 U.S.C. §§ 1531–1543) provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction. The ESA defines an endangered species and provides for the designation of critical habitats. Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. Under Section 7(a) of the ESA, federal agencies must carry out conservation programs for listed species. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented. Consultation regulations at 50 C.F.R. § 402 are administrative in nature and therefore are not ARARs. However, the DON will comply with substantive provisions of the ESA (Cal. Fish & Game Code § 2080). Discussions with regulatory agencies have taken place, and a Biological Opinion has been prepared that includes procedures for ensuring compliance with the ESA.

Coastal Zone Management Act

Under the CZMA, federal land is specifically excluded from the definition of a coastal zone. The CZMA (16 U.S.C. §§ 1451–1464) and the accompanying implementing regulations in 15 C.F.R. § 930 require that federal agencies conducting or supporting activities directly affecting the coastal zone conduct or support those activities in a manner that is consistent with the approved state coastal zone management programs. A state coastal zone management program developed under state law and guided by the CZMA sets forth objectives, policies, and standards to guide

public and private uses of lands and water in the coastal zone. Activities affecting the coastal zone, including lands there-under and adjacent shore land, will be conducted in a manner consistent with approved state management programs. This ARAR is relevant and appropriate but not applicable because federal land is excluded from the definition of a coastal zone.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. §§ 703–712) prohibits at any time, using any means or manner, the pursuit, hunting, capturing, and killing or attempting to take, capture, or kill any migratory bird. This act also prohibits the possession, sale, export, and import of any migratory bird or any part of a migratory bird, as well as nests and eggs. A list of migratory birds for which this requirement applies is found in 50 C.F.R. § 10.13.

California Fish & Game Code

See the discussion of endangered species above.

10.2.3 Action-Specific ARARs

The selected remedy includes institutional controls, groundwater monitoring, and capping activities for which action-specific ARARs are discussed below.

10.2.3.1 Institutional Controls

Institutional controls are required to maintain the integrity of the landfill by preventing excavations or increased infiltration of surface water; preventing land use that presents unacceptable risk to human health due to residual contamination; preventing use of contaminated groundwater; protecting groundwater monitoring wells; and restricting access to the site and the monitoring wells. Institutional controls for IA-H1 include land-use restrictions designed to protect the landfill remedy. Any potential future transfers would initiate the appropriate provisions to ensure that institutional controls follow with the ownership of the property. Property transfers from the DON to another federal agency are typically implemented by means of a memorandum of understanding (MOU) and do not require an environmental restriction covenant and agreement. Substantive provisions of identified State ARARs (California Civil Code, § 1471 and California Health and Safety Code, § 25202.5) that implement restrictive environmental covenants in the deed at the time of transfer would be implemented if the site were to be transferred to a non-federal entity. These covenants would be recorded with the

environmental restriction covenant and agreement and would be implemented at the time of conveyance. The United States Department of the Interior requires that the DON institute a conservation easement for protection of the salt marsh harvest mouse through use of a 25202.5 hazardous waste (HW) restrictive easement.

The DON's intention is to pursue title transfer of IA-H1 to an interested party or parties, including reversion to the State. Prior to a title transfer, the monitoring and enforcement of land use restrictions and institutional controls specified in the Remedial Action Plan (RAP)/Record of Decision (ROD)/RCRA Closure Plan will be incorporated into the Post-Closure/Post-Remedy Operations and Maintenance (O&M) Plan. The Navy intends that this work be performed by WESTON in accordance with the existing Environmental Services Cooperative Agreement. In the event all or a portion of IA-H1 is transferred or leased, the deed or Finding of Suitability to Lease will incorporate applicable land use restrictions and institutional controls.

10.2.3.2 Groundwater Monitoring

Groundwater monitoring is included as part of the selected remedy. Federal and state requirements that pertain to groundwater monitoring for corrective action programs are described in the following sections.

Portions of the RCRA groundwater protection standards contained in Cal. Code Regs. Title 22 are considered to be relevant and appropriate for the groundwater potentially impacted by releases from IA-H1 RCRA-regulated units and because the hazardous constituents addressed by this action for the Facility Landfill Areas are similar or identical to those found in RCRA hazardous wastes. Cal. Code Regs. Title 22, § 66264.100 requires that a water quality monitoring program be established to demonstrate the effectiveness of a corrective action program. Substantive provisions of the following requirements apply to the development and implementation of a groundwater monitoring program:

- Monitoring (Cal. Code Regs. Title 22, § 66264.91[a][1], [2], [3], [4], [b], and [c])
- Chemicals of Concern (Cal. Code Regs. Title 22, § 66264.93)
- Monitoring points and points of compliance (Cal. Code Regs. Title 22, § 66264.95[a])
- Monitoring parameters (Cal. Code Regs. Title 22, § 66294.98[b], [c], [f], [g], and [i])

- Statistical method for detecting a release (Cal. Code Regs. Title 22, § 66264.97[b][1] [A], [B][1], [2], [3], [C][1], [2], [D][1], [2], [b][2], [4], [5], [6], and [7], [e][1], [3], [5], [6], and [11], and [e][12][B])
- Evaluation monitoring (Cal. Code Regs. Title 22, § 66264.99[b], [c], [e], [f], and [g])
- Corrective action monitoring (Cal. Code Regs. Title 22, § 66264.100[c], [d], and [g][1] and [3])

The Containment Area includes a 25-acre area with RCRA regulated units (landfill, industrial wastewater treatment plant, and four surface impoundments), as well as an additional area of approximately 45 acres used for land disposal prior to RCRA regulations. The RCRA units within the Containment Area were issued an interim status document 11 December 1981, and denied an operating permit on 30 September 1988. The soil in the 45-acre non-RCRA area is contaminated with metals, pesticides, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and free product that presents a threat to groundwater. Shallow groundwater-bearing zone (SWBZ) beneath the Containment Area and in some areas outside the Containment Area is characterized with undifferentiated waste-related contamination.

Based on these considerations, the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) required that an Interim POC (IPOC) be established along the outside boundary of the Containment Barrier encircling the Containment Area. Groundwater protection standards apply to the three groundwater-bearing zones located hydraulically down gradient of the RCRA-regulated units. Groundwater quality monitoring points intersect these three zones. The DON concurred with the Water Quality Sampling and Analysis Plan (WQSAP), Revision 2, Investigation Area H1 RCRA/Facility and IWTP Surface Impoundments Groundwater Evaluation Monitoring Program, Mare Island, Vallejo, California, August 2005 (WESTON, 2005e). The WQSAP establishes the concentration limits for naturally occurring metal constituents, which are the background concentrations in all three water-bearing zones at IA-H1; the concentration limits for anthropogenic organic compounds are the laboratory reporting limits. The WQSAP addresses the groundwater monitoring issues and will be modified once the site is closed to reflect post-closure monitoring requirements.

The DTSC identified the following requirements for the development of a corrective action monitoring program for landfill closure: Cal. Code Regs, Title 22 Division 4.5, Chapter 12 and Chapters 15 and 18, as referenced in Chapter 12.

The substantive provisions of the Cal. Code Regs. Title 22 sections cited above are federal ARARs.

10.2.3.3 Capping

Under Cal. Code Regs. Title 22, § 66264.310(a)(7), a variance is allowed from any of the prescriptive cap requirements as long as it is demonstrated that the prescriptive cap is not necessary to protect public health, water quality, or other environmental quality. Under Cal. Code Regs. Title 27, § 20080(b), engineered alternatives to the prescriptive landfill cover are allowed when the discharger can demonstrate that the construction of prescriptive standard is not feasible and there is a specific engineered alternative.

Under Cal. Code Regs. Title 27, § 21090, the Water Board can allow any alternative final cover that it finds will continue to isolate the waste at least as well as would a final cover built in accordance with applicable prescriptive standards.

The remedial design will include a demonstration that the engineered alternative will provide equivalent protection against water quality impairment.

Landfill closure and post-closure requirements are contained in 40 C.F.R. § 258 and Cal. Code Regs. Titles 22, and 27. The landfill addressed in this RAP/ROD/RCRA Closure Plan ceased operation in 1989, prior to the effective date of 40 C.F.R. § 258 and Cal. Code Regs. Title 27. These are similar but not identical regulations, which are not “applicable” requirements. Therefore, the DON reviewed them to determine whether these regulations are potentially “relevant and appropriate” requirements. When federal and state regulations were considered to be equally stringent, federal regulations were selected as controlling ARARs. Federal and state requirements for landfill closure are the primary sources of ARARs for this action.

RCRA

IA-H1 contains an interim status hazardous waste RCRA Landfill, a Facility Landfill, and connected debris areas. The RCRA landfill closure requirements (Cal. Code Regs. Title 22, § 66264.111 and 66264.310) are general performance standards that eliminate the need for further

maintenance and control and eliminate post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.

The grading conducted for the capping/cover options at IA-H1 does not constitute placement or disposal under RCRA and, therefore, the generator requirements for hazardous waste determinations contained in Cal. Code Regs. Title 22, § 66265.310 are not triggered.

Consolidation would involve excavating hot spots within IA-H1 for the purpose of consolidating waste within the IA-H1 Containment Area. The RCRA regulated units and adjacent areas within the Containment Barrier would then be capped. The EPA has determined that disposal occurs when waste is placed in the land-based unit. However, movement within a unit does not constitute disposal or placement, and at CERCLA sites, an area of contamination can be considered comparable to a unit. Therefore, movement within the IA-H1 boundary does not constitute placement and RCRA waste generation and land disposal restrictions are not triggered.

The corrective action management unit (CAMU) requirements are federal ARARs for the IA-H1 Containment Area, where the excavated soil from remedial action sites will be placed. These requirements are set forth in Cal. Code Regs. tit. 22, § 66264.552(c) and (e); they allow for consolidation of wastes in a more cost-effective approach while still protecting human health and the environment. Placement of remediation wastes into or within a CAMU does not constitute land disposal of hazardous waste or creation of a unit subject to minimum technology requirements and, as such, is not subject to land disposal requirements. With this RAP/ROD/RCRA Closure Plan for Investigation Area H1, the Containment Area within IA-H1 is designated as a CAMU like unit for the consolidation of excavated soil from 1) hot spots within IA-H1, 2) IR-16/B3 and IR-16/B5, and 3) the Marine Corps Firing Range, by applying the substantive CAMU regulations but not the procedural requirements. The Containment Area within IA-H1 is also designated as a CAMU like unit for the consolidation of excavated soil from other Mare Island Remediation Sites. The consolidation within the IA-H1 Containment Area of excavated soil from other Mare Island Remediation Sites shall be subject to review and approval by DTSC. These other areas from which remediation waste will be removed and consolidated within the IA-H1 Containment Area will then be available for best use as defined in other site-specific cleanup plans. Wastes from other Mare Island Remediation Sites may be treated to allow for consolidation within the IA-H1 Containment Area. Waste that may be deemed acceptable for consolidation within the IA-H1 Containment Area shall be non-liquid, not

excessively volatile, and not excessively mobile. These are also acceptance criteria for soil from other Mare Island remediation sites. Compliance with the following seven criteria of Cal. Code Regs. tit. 22, § 66264.552(c) was evaluated:

1. The CAMU shall facilitate the implementation of reliable, effective, protective, and cost-effective correction action measures.

The use of the Containment Area at IA-H1 as a CAMU like unit for the disposal of excavated soil from the Marine Corps Firing Range (MCFR) and for Mare Island sites approved by DTSC, is a reliable, effective, and protective remedy, as long as source materials are evaluated against the above three acceptance criteria. A landfill cap will be placed over the consolidated soil to limit mobilization of contaminants and minimize potential exposure. The containment barrier already installed will prevent groundwater from the area from moving outside the Containment Area. The use of the Containment Area at IA-H1 as a CAMU like unit is more cost-effective than other alternatives, for remedies elsewhere on Mare Island, such as leaving waste in place and off-site disposal. This avoids impacts such as transportation related risks, air quality and traffic issues.

2. Waste management activities associated with the CAMU shall not create unacceptable risks to humans or to the environment resulting from exposure to hazardous wastes, hazardous substances, or hazardous constituents.

The consolidation of excavated soils from the MCFR and other DTSC approved Mare Island sites are not expected to result in any unacceptable risks at IA-H1. Material consolidated into the Containment Area will be of similar or lower contamination levels of the existing material and therefore will not change the overall contaminant characteristics. The landfill cap will prevent direct future exposure to humans and the environment. Based on Containment Area modeling using site-specific conditions and average concentrations, leaching to groundwater will not pose unacceptable risk to human health.

3. The CAMU shall include uncontaminated areas of the facility only if including such areas for the purpose of managing remediation waste is more protective than management of such wastes at contaminated areas of the facility.

Excavated soil from Mare Island sites will only be located within the existing footprint of the Containment Area and will not include uncontaminated areas.

4. Areas within the CAMU where wastes remain in place after closure of the CAMU shall be managed and contained so as to minimize future releases, to the extent practicable.

The Containment Area will be capped to contain the excavated soil and minimize the potential for future releases from the soil to groundwater. The cap will be regularly maintained as detailed in the Operations and Maintenance Plan. The existing groundwater containment barrier and extraction system will eliminate the lateral migration of shallow groundwater.

5. The CAMU shall expedite the timing of corrective action activity implementation, when appropriate and practicable.

Using the IA-H1 Containment Area for consolidation of excavated soil from the MCFR and other DTSC approved Mare Island sites will expedite the remedial action because it will take less time than off-site disposal and provide base material upon which to build the Containment Area cap.

6. The CAMU shall enable the use, when appropriate, of technologies (including innovative technologies) to enhance the long-term effectiveness of corrective actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU.

The mobility of contaminants in the soil excavated from the MCFR and other DTSC approved Mare Island sites will be reduced when placed in the Containment Area because the containment barrier will prevent migration of groundwater and because the landfill cap will be placed over the excavated soil. Also, waste proposed for disposal in the CAMU like unit, but which initially fails any of the three acceptance criteria, may be treated to meet acceptance criteria and this CAMU specific criterion.

7. The CAMU shall, to the extent practicable, minimize the land area of the facility upon which wastes will remain in place after closure of the CAMU.

Because a potentially feasible alternative for hot spots in IA-H1 or the MCFR or other areas of contamination at MINS is capping in place, the consolidation of soil from the MCFR or other DTSC approved Mare Island sites in to the IA-H1 Containment Area will aid in minimizing the land area of Mare Island within which wastes will remain in place. The Containment Area footprint will remain the same as currently defined by the existing groundwater containment barrier.

The design, operation, and closure and postclosure requirements for the CAMU like unit are covered in the overall IA-H1 Containment Area and RCRA closure and postclosure requirements. The requirements for groundwater monitoring at IA-H1 are included in the Design Document and Water Quality Sampling and Analysis Plan. Substantive requirements and ARARs for groundwater monitoring are discussed in section 10.2.3.2.

The DTSC approved the use of the DI WET test for soil excavated at the Marine Corps Firing Range because it is more appropriate as it more closely matches the leachate characteristics likely to occur at IA-H1 than using the CCR Title 22WET or the Toxicity Characteristic Leaching Procedure (TCLP) (DTSC 4-19-2006).

CRITERIA FOR MUNICIPAL WASTE LANDFILLS, TITLE 40 C.F.R. § 258

Landfill closure requirements for municipal waste landfills are set forth in 40 C.F.R. § 258, subpart F. Because IA-H1 did not receive wastes after the effective date of these requirements (9 October 1991), these requirements are not applicable. However, the substantive portions of these requirements are considered potentially relevant and appropriate.

Provisions in Title 40 C.F.R. § 258.60(a) and (b) require that the final cover system be designed to minimize infiltration and erosion. This section provides specific technical standards for cover design but allows for alternative cover designs if it is demonstrated that the alternative designs will achieve the same level of performance.

40 C.F.R. § 258.61 requires post-closure maintenance for 30 years unless it can be demonstrated that a shorter or longer period of maintenance is required. If it can be demonstrated that the site

poses no threat to public health and safety or to the environment, the post-closure maintenance period may be eliminated.

CLEAN AIR ACT

Bay Area Air Quality Management District (BAAQMD) rules for emissions include Regulation 8 Organic Compound Rule 34 and Rule 2 for controlling emissions from landfills and miscellaneous operations. It is assumed at this time that all these rules have been approved by EPA in the BAAQMD State Implementation Plan and are therefore federal ARARs. Emission controls, if needed for landfill gas, will be evaluated in the design document.

SOLID WASTE (CAL. CODE REGS. TITLE 27, DIV. 2)

The State has identified numerous operating requirements for the placement of waste in landfills including daily cover requirements, gas monitoring, and others. The State identifies these requirements as applicable to “consolidation sites”; however, a consolidation site is a remote site where hazardous wastes are consolidated. IA-H1 is one site and is not a remote site. Substantive provisions that are relevant and appropriate and are more stringent than Federal requirements were retained where the activity was applicable to the remedy. Specific activities listed by the State but which were determined not to be applicable, include items such as scavenging and stockpiling, which are not part of the remedy and were not retained. Procedural elements are also not applicable to a CERCLA site. Relevant and appropriate ARARs were retained and will be complied with during the implementation of the remedy and closure of the site.

10.2.3.4 California Fish and Game Code

The State-identified ARARs regarding streambed alteration of Cal. Fish and Game Code § 1601 is not an ARAR because it is not a requirement of general applicability and only applies to state and local governments and utilities. Cal. Fish and Game Code §1603 is also not applicable to federal lands. These ARARs were not retained. As noted earlier, the DON will comply with substantive provisions of the ESA Cal. Fish & Game Code § 2080.

10.2.3.5 Groundwater Containment

WESTON prepared a Final Action Memorandum/Interim Remedial Action Plan (AM/IRAP) to document the DON's decision to undertake a Time Critical Removal Action within IA-H1 (WESTON, 2004a). The IA-H1 AM/IRAP involved constructing a vertical groundwater Containment Barrier (slurry wall and groundwater collection trench) around the perimeter of the Mare Island historical landfill. The Final AM/IRAP was signed and approved by DTSC and DON in March 2004, and the work completed in September 2004. The Containment Barrier surrounds at least three potential sources of groundwater contamination in IA-H1, eliminates lateral migration of hazardous substances and contaminants of concern within the SWBZ, and reduces the potential for vertical migration of contaminants. Containment was considered the most feasible and effective manner to ensure protection of SWBZ groundwater.

Federal

Based on operations and testing data obtained since the groundwater extraction trench operation began, the extracted water has had chemical concentrations well below RCRA characteristic waste levels. The water meets all Vallejo Sanitation and Flood Control District (VCSFD) requirements for discharge and carries a landfill leachate code. If any of the tested wastes (well development water or extracted groundwater) is determined to be hazardous, then the appropriate hazardous waste handling requirements will apply.

State

Waste streams generated in the course of implementing the remedy will also be characterized with respect to state criteria for identification of non-RCRA hazardous waste. Any waste exhibiting a characteristic of RCRA-hazardous waste will be managed in accordance with the appropriate requirements of Cal. Code Regs., Title 22, § 66264.

11. RCRA CLOSURE REQUIREMENTS

Closure requirements for the Resource Conservation and Recovery Act (RCRA) regulated units not covered in the Investigation Area H1 (IA-H1) Remedial Action Plan (RAP)/Record of Decision (ROD)/RCRA Closure Plan discussion are covered in this section. The checklist “*Cross-Reference to RCRA Closure Requirements*” on the next page shows where required closure plan elements are located in this document. Much of the basic information and remedy details have already been described in the previous sections. Substantial requirements of Title 22 Sections 66265.111 and 66265.310 are covered in this section and other sections of this RAP/ROD/RCRA Closure Plan and related documents as referenced.

This is an inactive RCRA site that has not received waste since 1987. The Interim Status RCRA areas are being closed in conjunction with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action at the whole IA-H1 site. Figure 11-1 shows the RCRA regulated facilities including the RCRA interim status landfill and the Industrial Wastewater Treatment Plant (IWTP) and Surface Impoundments. The description and history, including wastes historically accepted or treated are described in Section 2.4 of this document. The RCRA/Facility Landfill location is also illustrated in Figure 2-3, and it is estimated to contain 600,000 tons of refuse, at a maximum thickness of 42 feet in certain places.

As discussed in the previous sections evaluating the remedy for the site, the following factors were considered in addressing the remedy components and closure and post closure care of the site: the type and amount of hazardous waste and waste constituent in the landfill, the mobility and expected rate of migration, the site location, topography and surrounding land use and potential effects of pollution migration, climate, cover and runoff requirements, geological and soil profiles, and subsurface hydrology of the site. The design and installation of the Containment Barrier described in Section 2.5.2 accounted for containing contaminated groundwater and managing leachate. The Remedial Design Plan will address the details of cap design which is intended to minimize the chance of post closure release of hazardous waste, facilitate post closure maintenance, monitoring, and emergency response. The design will include provisions for run-on and run-off control to prevent eroding of the cap. The general cap description is included in Section 8.2.1.2, and details of the cap design will be included in the Remedial Design Plan.

11.1 RCRA FACILITY DESCRIPTION

Facility Address: 750 Dump Road
Vallejo, CA 94592

Owner: United States Navy
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310

Facility Operator: United States Navy

Mailing Address: Caretaker Site Office San Francisco Bay
Contact: Bob Palmer
410 Palm Ave, Bldg 1
San Francisco, CA 94130-1802

Preparer of Closure Plan: Weston Solutions, Inc.
1575 Treat Blvd. Suite 212
Walnut Creek, CA 94598

Nature of Business: Closed Naval Shipyard

Cross-Reference to RCRA Closure Requirements

RCRA Closure Requirement	Report Section
Facility Name EPA ID Number	Section 2.0
Facility address Mailing address Contact Person Facility operator Facility owner Preparer of Closure Plan Nature of business	Section 11.2
Environmental permits	Section 11.2
Certification	Section 11.4
Size	Section 2.3
Topographic map	Figure 11-2
The legal boundaries of the facility. The location of each closed hazardous waste treatment and storage unit All springs and surface water bodies Land uses	Figure 11-1
Hydrogeologic conditions	Section 2.3.2
Weather and climatic conditions	Section 2.3.3
Size and dimensions of each unit/area design capacity or throughput Ancillary equipment and structures associated with each unit Types of containment systems Layout drawings Estimate and management of maximum inventory Permitted waste capacity	Section 2.4 The site is not active; there are no buildings, ancillary equipment or containment systems on the site other than the slurry wall discussed in Figure 11-1 shows the layout of the RCRA facility Section 2.4
Waste generated during closure	Section 11.3.2
Personal protective garments and equipment Decontamination procedures	Site-Specific Health and Safety Plan Weston Solution, Inc. [WESTON], 2003b) will be updated during the design phase
General description of confirmation soil sampling locations and depths Types of soil samples Sample collection methods Quality control samples Chain-of-custody Sample labeling, packaging, and transportation Documentation	Section 8.2 Alternative Description Selected remedy does not require confirmation soil sampling at the RCRA Facility Draft Final IA-H1 Remedial Design Plan (WESTON, 2006c) describes mitigation measures and related sampling
Analytical test methods	Draft Final Water Quality Sampling and Analysis Plan (WESTON, 2005e) Draft Final IA-H1 Remedial Design Plan (WESTON, 2006c)
Groundwater sampling	Draft Final Water Quality Sampling and Analysis Plan (WESTON, 2005e)
Closure cost estimates	Table 12-1 Detailed estimates included in the Feasibility Study (FS) (WESTON, 2006a)

11.2 ENVIRONMENTAL PERMITS

The interim status RCRA Facility is being closed as part of a larger CERCLA site. The whole site is being closed in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the California Health and Safety Code Chapters 6.5 and 6.8. Under CERCLA Section 121(e), no Federal, State or local permit is required for on-site CERCLA response actions. The United States Environmental Protection Agency (EPA) has interpreted CERCLA Section 121(e) to waive the requirement for obtaining a permit and associated administrative and procedural requirements of permits, but not the substantive requirements that would be applied through permits. Substantive permit requirements will be complied with and the design will incorporate provisions for compliance with the Construction National Pollution Discharge Elimination System (NPDES) general permit. The NPDES requirements will be briefly described in a technical specification, and are currently part of the IA-H1 Stormwater Pollution Prevention Plan. Substantive RCRA closure requirements are being followed for this site. A Draft Final Water Quality Sampling and Analysis Plan (WQSAP) is currently being used and will be modified once remedial activities are complete to meet RCRA corrective action monitoring requirements. A Post-Closure Plan will encompass the site post-closure requirements including post-closure operations and maintenance (O&M) activities for the RCRA Interim Status facility. Substantive requirements for non-tidal wetland mitigation will also be followed and are included in the Wetland Mitigation and Monitoring Plan (LSA, 2006b). A Biological Opinion developed by the Fish and Wildlife Service requires compliance with mitigation measures that include trapping and moving of the salt marsh harvest mouse (if found) and creating new wetlands to replace lost habitat that will be implemented for this project.

11.3 CLOSURE ACTIVITIES

11.3.1 Site Activities

Remedial and construction activities will commence once the Final RAP/ROD/RCRA Closure Plan is approved. Site remedial activities are anticipated to last approximately six months for the RCRA units. Pre- construction activities include preparation of this document and associated plans and design documents. The design document for the landfill cap incorporates design specifications to meet seismic stability requirements. Remedial and construction activities for the

RCRA/Facility Landfill include grubbing, grading, installation of a RCRA Subtitle C cap, and construction of the mitigated wetlands. The IWTP pipeline was reportedly flushed and cleaned when the IWTP ceased operations. On July 21, 2005 DTSC approved the final pipeline closure plan. The IWTP pipeline was video surveyed, cleaned, and rinsate tested in accordance with a DTSC-approved work plan, in November 2005. A closure report was submitted detailing the closure according to the approved plan. With this RAP/ROD/RCRA Closure Plan, DTSC has determined that the IWTP pipeline has been clean closed. However, to reduce potential for future contaminant migration along preferential pathways, hydraulic barriers will be constructed across the utility preferential pathways in IA-H1. Locations for these hydraulic barriers will be specified in the Remedial Design Plan. The following will be performed in preparation for site remedial action and construction activities:

- The Site-Specific Health and Safety Plan (WESTON, 2003b) will be updated, as necessary, to include required personal protective equipment, decontamination procedures, and activity hazard analysis for construction activities.
- Site access delineation, establishment of exclusion zones, support zones, equipment decontamination areas, materials handling and staging areas, and equipment mobility within work areas will be established.
- Construction activities will be performed to the requirements specified in the design plan. The general descriptions of the RCRA cap and wetland mitigation are provided in Section 8.2 of this document. Site construction activities will include approximately 2 weeks of initial site preparation, clearing and grubbing, sub-grade preparation, 6 weeks for installation of the cap system, and 2 weeks for hydro-seeding to provide re-vegetation of the cover surface.
- Surface run-off control will be included in the design to meet cap and mitigated wetland requirements. Surface run-off controls during construction are described in the Stormwater Pollution Prevention Plan (WESTON, 2004d).

The Draft Final IA-H1 Remedial Design Plan (WESTON, 2006c) describes the design of the cap and implementation of the remedy in detail including confirmation sampling, soil cover and

wetland creation soil criteria, construction, safety, quality control practices, and construction practices.

11.3.2 Waste Generation

Wastes generated during construction are anticipated to include project-derived wastes, such as spent personal protective equipment, disposable equipment and materials, and decontamination wastes. All wastes will be characterized, profiled, and disposed of at the appropriate permitted facility. No generation of hazardous waste is anticipated, since installation of the cover will not require contact with or disturbance of the existing waste materials. Non-hazardous liquid wastes, such as decontamination rinse water, expected to be a negligible volume, will be analyzed to confirm compliance with the Vallejo Sanitation and Flood Control District (VSFCD) discharge criteria and will be discharged to the sanitary sewer system. The combined groundwater and leachate will also be sampled and analyzed for contaminants consistent with the groundwater monitoring program required for the Containment Area. If unanticipated hazardous wastes are generated, then any such waste will be characterized, profiled, and disposed of at the appropriate permitted facility. Any hazardous wastes generated for off-site disposal will be disposed at a permitted Class 1 facility such as Chemical Waste Management, Kettleman Hills, California, or equivalent. Any liquid hazardous wastes will be disposed at the appropriate facility to handle such contaminants, such as Romic Chemical in East Palo Alto, California, or equivalent. Waste will be properly packaged and labeled in accordance with all applicable rules and regulations. Wastes will be handled in a manner that prevents release of potentially contaminated material to the environment and protects worker safety and health during remedial activities. Care will be taken during operations to minimize the waste generated. Volumes of wastes generated are anticipated to be consistent with investigation derived waste and decontamination activities for the construction of the landfill cap.

11.3.3 Post-Closure Activities

A Closure Report will be prepared to document the implementation of activities described in this RAP/ROD/RCRA Closure Plan. Included in the report will be a synopsis of the work completed and certification by a State of California Professional Engineer. The report will explain any modifications to the design, and documentation substantiating that the work has been completed

to the design standards, including confirmation sampling results, and results from testing any imported material.

A Post-Closure O&M Plan will be developed to describe the specific requirements of long term maintenance of the cap that will include but not necessarily be limited to: periodic visual inspection of the cover for damage or potential for damage (burrowing animals), settlement monitoring, groundwater extraction trench operation, surface water control, vegetation control, burrowing animal control, on-going education and awareness program, fence maintenance and signage. Inspections will be performed and scheduled based on the requirements and need for inspection of specific elements. The purpose of this plan is to ensure that the integrity and effectiveness of the remedy is maintained. The plan will cover procedures for identifying potential or current problems with the containment system beginning with monthly inspections. Maintenance of surveyed benchmarks will be done through yearly inspections. Benchmarks and monuments will be re-surveyed regularly and results will be compared to the initial survey; settlement and movement will be recorded. The Post Closure O&M Plan will detail the operation and maintenance of the extraction trench including groundwater and leachate handling and the gas venting system. The plan will identify on-going maintenance items such as control of damaging vegetative growth (trees etc.) based on need identified during inspections. This O&M plan will meet the requirements of California Code of Regulations (CCR) Title 22, Section 66264.310. Groundwater monitoring has been outlined in the Final WQSAP (WESTON, 2005e). The WQSAP will be updated to include the post-closure requirements.

11.4 CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Signature: Michael S. Bloom

8/4/06

Michael S. Bloom
Department of the Navy
Base Realignment and Closure Environmental Coordinator
Mare Island Naval Shipyard
BRAC Program Management Office West

Date

11.4 CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Signature: _____

Michael S. Bloom
Department of the Navy
Base Realignment and Closure Environmental Coordinator
Mare Island Naval Shipyard
BRAC Program Management Office West

_____ Date

12. SELECTED REMEDY

Figure 12-1 shows the combined preferred remedial action for Investigation Area H1 (IA-H1). The selected alternatives based on the analysis summarized in this Remedial Action Plan (RAP)/Record of Decision (ROD)/Resource Conservation and Recovery Act (RCRA) Closure Plan and presented in the IA-H1 Final Feasibility Study (WESTON, 2006a) are as follows:

Containment Area – Alternative 2A:

Multilayer Variable Cap, Institutional Controls, Groundwater Containment, and Gas Monitoring

Upland Areas – Alternative 4:

Institutional Controls, Hot Spot Removal (Hazard Quotient [HQ]=3), Groundwater Monitoring, and 2-Foot Soil Cover

Non-Tidal Wetland Areas – Alternative 5:

Institutional Controls, Hot Spot Excavation (HQ=1), and Monitoring

The preferred remedy measures are summarized as follows:

- Installation of the Containment Area cap, groundwater Containment Barrier (already installed), exclusion fence, landfill gas venting, and monitoring.
- Hot spot removal in the Upland (HQ=3) and Non-Tidal Wetland Areas (HQ=1) and consolidation of excavated soil within the Containment Area prior to capping.
- Creation of 8.2 acres of wetlands within the Upland Areas, consisting of 6.7 acres of pickleweed-dominated wetlands, and 1.5 acres of seasonally ponded wetlands, and long-term annual monitoring.
- Placement of a vegetated 2-foot soil cover in remaining portion of the Upland Areas.
- Groundwater monitoring for the Containment Area and Upland Areas.
- Monitoring in the Non-Tidal Wetland Areas.
- Institutional controls and long-term operation and maintenance of the remedy.

Institutional controls, in the form of land use restrictions, will be placed on the property to prohibit the development of the land for unauthorized uses. The following land use restrictions will be placed on the site as deed restrictions:

- Future reuse of the property for residential, school, daycare center, or hospital uses is prohibited.
- None of the following activities will be conducted unless the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) provides written approval:
 - Covering or disturbing of groundwater wells in a manner that restricts access to groundwater wells
 - Alteration of groundwater conditions, through activities such as groundwater pumping
 - Soil/sediment disturbing activities by the public
 - Construction of buildings or any other structures
 - Grazing and agricultural activities of any type
 - Altering the surface or general topography of the property, including building roads, paving, or otherwise covering the property

In addition, the terms and conditions specified within the Final Biological Opinion will be maintained. The IA-H1 Draft Final Remedial Design Plan (WESTON, 2006c) describes the design of the cap and implementation of the remedy in detail including confirmation sampling, soil cover and wetland creation soil criteria, construction, safety and quality control practices, and construction practices. A final Remedial Design Plan will follow the approval of this RAP/ROD/RCRA Closure Plan.

12.1 PERIODIC REVIEWS

As required by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121(c), for sites where wastes are left in place, periodic reviews will occur every 5 years, in addition to quarterly inspections and annual reports. Five-year reviews of federal facilities are a federal agency function intended to evaluate whether immediate threats have been addressed; the remedial action remains protective of public health and the environment; and necessary long-term monitoring is being performed. Inspection frequencies

may change in the future. Any changes will be re-evaluated during the 5-year review. The review of IA-H1 is expected to focus on whether the land-use controls are in place and are sufficient to assure protection, whether groundwater remediation is preventing migration of chemicals of concern (COCs), and that the effectiveness of the remedy remains sufficient.

The 5-year reviews will be conducted by the United States Department of the Navy (DON), which will prepare and submit reports to the DTSC and the California Environmental Protection Agency San Francisco Bay Regional Water Quality Control Board. The reviews will clearly state whether the remedy is expected to be protective, document any deficiencies identified during the review, and recommend specific actions to assure that the remedy will continue to be protective. If necessary, the 5-year review reports will include descriptions of follow-up actions needed to achieve or to continue to assure protectiveness along with a timetable for these actions.

12.2 POST CLOSURE OPERATIONS AND MAINTENANCE AND LONG-TERM MONITORING PLAN

A Post-Closure Operations and Maintenance Plan will be developed to describe the specific requirements of long term maintenance of the site. The plan will include but not be limited to: periodic visual inspection of the cover and settlement monitoring of the Containment Area, groundwater extraction trench operation, maintenance of the soil covers, and vegetation control. Monitoring for the wetland areas and inclusion of the requirements of the Biological Opinion for maintenance and monitoring will be included as well as implementation of institutional controls.

This plan will be developed after the remedial design phase and will include the post-closure number and location of monitoring wells. It will also specify sampling and analysis methods, analytes, and sampling frequency for each well. The criteria for assessing the effectiveness of the remedial action will also be included in the long-term monitoring plan. Groundwater monitoring was outlined in the Draft Final WQSAP (WESTON, 2005e)

The groundwater extraction system will remain in operation continuously, or intermittently as needed, to maintain a lower groundwater level within the Containment Barrier compared with the groundwater level outside the barrier.

12.3 RATIONALE FOR REMEDY SELECTION

The selected alternative provides the best balance with respect to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) evaluation criteria. The information available at this time shows that the selected alternatives offer a high level of performance when assessed against the following NCP evaluation criteria: short-term effectiveness (short term impacts are acceptable); long-term effectiveness and permanence; implementability; compliance with Applicable or Relevant and Appropriate Requirements (ARARs); and overall protection of human health and the environment. These alternatives are cost-effective means of accomplishing the Remedial Action Objectives (RAOs) for the site.

This selected remedy fulfills the RAOs developed for the site. The outline of the Containment Area was selected to include the areas known or suspected to contain the most contaminated sites and those that could present the greatest threat to groundwater. The variable multilayer cap meets the requirements for the prescriptive RCRA hazardous waste requirements and California performance based requirements for landfill caps including the RCRA non-hazardous waste landfill requirements. The caps meet the landfill RAO of protecting human and ecological receptors from exposure to landfill contamination by minimizing exposure pathways and contaminant migration. The cap will isolate the wastes to eliminate direct contact of receptors with wastes and minimize leachate and landfill gas migration. The cap, groundwater extraction trench, slurry wall and monitoring program act together to meet the groundwater RAO of protecting human and ecological receptors in the area from potentially harmful exposure resulting from leachate migration into groundwater and subsequently into surface water. The groundwater monitoring program ensures that no contaminants will migrate off site. The soil cap combined with the landfill gas monitoring and control program fulfills the RAO for landfill gas of protecting human health and the environment from subsurface methane gas migration. The cap will greatly reduce risks to human health and the environment. The cap minimizes formation of leachate by preventing rainwater from infiltrating the landfill. The vegetative cover and properly designed runoff controls will prevent erosion from damaging the cap. The cap will eliminate the possibility of direct contact of humans and animals with landfill waste, and will minimize the potential for erosion, formation of leachate, and migration of surface contaminants. In addition, implementation of Alternative 2A variable multilayer cap, will not pose unacceptable short-term risks or cross-media impacts.

Hot spot removal in the Upland and Non-Tidal Wetland Areas removes contaminated soils and leaves in place materials with lower acceptable risks. The affected Upland Areas will also have a 2-foot soil cover applied that will provide added risk reduction by providing a barrier to the remaining soil. Groundwater monitoring will ensure that if there is contamination moving from the Upland Areas to the Wetland areas it is identified and appropriate actions taken. Non-Tidal Wetland Areas disturbed by remedial activities will be restored. In addition, newly created wetland areas will provide a larger area of functional wetlands. Inspections and long term monitoring that will be developed in the Post Closure Care/Operations and Maintenance/Monitoring plan will ensure that the remedies remain effective.

Table 12-1 summarizes the cost estimates for the selected alternatives, including capital and long-term monitoring costs assumed to extend for 30 years for the Containment Area and areas outside the Containment Barrier. The assumed 30-year time frame does not necessarily reflect the duration of the long-term monitoring activities at the site; the results of sampling designed to evaluate the effectiveness of remediation will determine whether long-term monitoring activities are discontinued or extended.

The total cost for Alternative 2A (variable multilayer cap, gas monitoring, institutional controls, and groundwater containment) including operations and maintenance (O&M) and regulatory oversight costs, is \$31,300,000. Approximately \$2,390,000 of the total has already been spent to install the Containment Barrier. The total cost for Alternative 4 (hot spot removal with an ecological HQ of 3, 2-foot soil cover, and groundwater monitoring) in the Upland Areas is \$3,160,000. The total cost for Alternative 5 for the Non-Tidal Wetland Areas (hot spot removal with an ecological HQ of 1, institutional controls, and monitoring) is \$365,000. The total cost for implementing the remedy at IA-H1 is \$34,825,000.

12.4 PUBLIC PARTICIPATION

The United States Department of the Navy (DON) developed a Community Relations Plan to document concerns identified during community interviews and to provide a detailed description of community relations activities planned in response to information received from the community. The most current Final Community Relations Plan is dated 23 August 2001 (DON, 2001).

The community relations program includes specific activities for obtaining community input and keeping the community informed. These activities include conducting interviews, holding public meetings, issuing fact sheets to provide updates on current cleanup activities, maintaining an information repository where the public can access technical documents and program information, disseminating information to local and regional media, and making presentations to local groups. An information repository is maintained at the John F. Kennedy Library at 505 Santa Clara Street in Vallejo for easy access by the public.

The RAB for Mare Island was formed in 1994 to review and discuss current and projected environmental investigation activities at Mare Island. Meetings of the RAB include updates on field activities, funding issues, and other technical and administrative matters, and are open to the public. The RAB meets monthly to discuss project progress, review reports, and comment on investigation and cleanup activities. The DON funded a Technical Assistance for Public Participation (TAPP) grant for the Mare Island RAB to provide for an independent review of the IA-H1 Draft and Draft Final RI reports. Results from this review were discussed with the RAB and comments forwarded to WESTON and the DON for consideration and/or incorporation.

The remedial alternatives proposed in the IA-H1 Draft FS were discussed at a RAB meeting in January 2005. An independent review of the Draft FS, funded through a second TAPP grant for the RAB, was conducted in early 2005, and the results were discussed at the April 2005 RAB meeting. A RAB focus group meeting regarding the Draft Final FS was held with the community on October 4, 2005. This was a working community focus group to discuss site issues and gather community input for the Draft Final FS. The Draft Final FS was issued in October 2005 and the Final FS and Final Draft RAP/ROD/RCRA Closure Plan issued in May 2006. The RAP/ROD/RCRA Closure Plan was published and sent to interested parties on May 21, 2006. A Fact Sheet enclosed in Appendix A was mail to the public on May 19, 2006. A public comment period ran from May 30 to June 30, 2006. Notice of the meeting published in the local newspaper is attached in Appendix B. A public meeting to discuss the remedy presented in the Final Draft RAP/ROD/RCRA Closure Plan was held on June 1, 2006. A transcript of the meeting is enclosed in Appendix C and the responsiveness summary in Appendix D. The project administrative record is enclosed in Appendix F.

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