Section 6. Conceptual Site Model

The conceptual site model is an understanding of the dynamics of the site's environmental concerns and serves as the basis of the development of the RAOs. The conceptual site model is used to understand potential sources of contamination, migration pathways, and human and ecological receptors that the RAOs are intended to address. This section closely follows the EPA guidance document titled "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" and is based on Section 2.5 from the guidance (EPA, 1991a). This section is divided as follows:

- Potential sources of contamination (Section 6.1)
- Potentially affected media and migration pathways (Section 6.2)
- Contaminant exposure points, exposure routes, and receptors (Section 6.3)

The conceptual site model was developed by incorporating site-specific landfill characteristics into EPA's generic site conceptual model for municipal landfills (EPA, 1991). Figure 6-1 presents the Parcel E-2 site map, a representative hydrogeologic cross section, and a conceptual cross section of the gas control system for Parcel E-2. The site map provided on Figure 6-1 presents the extent of solid waste relative to San Francisco Bay, wetland areas within the Shoreline and Panhandle Areas, and nearby structures. Figure 6-1 also depicts the limit of the interim cap and gas control system (which are detailed further in the conceptual cross section) and the location of removal actions performed in the Panhandle and East Adjacent Areas. The hydrogeologic cross section depicts the depth of solid waste within the Parcel E-2 Landfill relative to the underlying aquifers. Figure 6-2 presents a schematic of potential release mechanisms and exposure routes from the Parcel E-2 Landfill. Figure 6-3 presents a flow chart of potential migration pathways and human and ecological receptors that may be exposed to chemicals from the landfill and adjacent areas (the Panhandle Area, East Adjacent Area, and Shoreline Area). Together, these graphical representations compose the site conceptual model for Parcel E-2.

6.1. POTENTIAL SOURCES OF CONTAMINATION

The primary potential source of contamination at Parcel E-2 is solid waste in the Landfill Area. The solid waste consists of a contiguous layer of waste materials covering approximately 22 acres (Figure 6-1). Based on data from 28 soil borings, 18 monitoring wells, and 25 test pits extended within the Landfill Area, solid waste is composed primarily of municipal-type waste and construction debris. The solid waste includes wood, paper, plastic, metal, glass, asphalt, concrete, and bricks mixed with sand, clay, and gravel fill. Historic information indicates that industrial wastes were also disposed of in or around the

Landfill Area; these wastes included sandblast waste, radioluminescent devices, asbestos-containing debris, paint sludge, solvents, and waste oils (NEESA, 1984; NAVSEA, 2004). The surface of the Landfill Area is covered with either soil or an interim cap consisting of multiple geosynthetic and soil layers (Figure 6-1). The interim cap, installed to prevent oxygen intrusion and extinguish smoldering subsurface areas following a brush fire, covers approximately 14.5 acres and limits infiltration of precipitation into portions of the underlying waste.

Another primary potential source of contamination is the industrial waste disposed of in the East Adjacent Area and Panhandle Area. Two known hot spots within these areas were removed under interim removal actions (Figure 6-1). Waste removed during the Metal Slag Area removal action includes metal slag and debris containing low-level radiological material and radioluminescent devices (Navy, 2005b through 2005f). In addition to this radiologically impacted debris, six waste drums were recovered from the Metal Slag Area and were characterized prior to off-site disposal. The drums, which were discovered in varying degrees of deterioration, contained grease, soil, plastic, metal, and wood. Waste characterization data indicated that five of the six drums contained various chemicals, including PCBs and petroleum hydrocarbons; the sixth drum contained elevated activities of radium-226 (TtECI, 2007b).

Waste encountered and removed during the PCB Hot Spot Area removal action includes oily wastes, radioluminescent devices, and sandblast waste (Navy, 2005b through 2005f). In addition, 110 drums and 537 assorted waste containers were recovered from the central portion of the PCB Hot Spot Area. The drums, which were discovered in varying degrees of decay, contained grease, oil, soil, asphalt, and tar substances. Waste characterization data indicated that the drums contained various chemicals, including PCBs and pesticides. Smaller containers contained various laboratory chemicals, ranging from strong acids and bases to solvents, alcohols, and inorganic salts (TtECI, 2007a).

Based on data from the 204 soil borings and test pits extended within the East Adjacent Area and Panhandle Area, fill material outside of the Metal Slag Area and PCB Hot Spot Area consists primarily of soil and rock fill, with lesser quantities of inert construction debris and isolated accumulations of putrescible construction debris (e.g., wood). With the exception of wood, the remaining types of construction debris are considered inert and are not expected to generate methane gas or leachate that would create potential risks to human health or the environment.

Secondary potential sources of contamination are media that may have been affected by the primary potential source (solid or liquid waste), such as soil (including artificial fill materials), sediment, groundwater, and subsurface air.

6.2. POTENTIALLY AFFECTED MEDIA AND MIGRATION PATHWAYS

Potentially affected media at Parcel E-2 consist of soil, subsurface air (gas emanating from the landfill), outdoor air, groundwater, surface water runoff, sediment, and wetlands (tidal and freshwater). The affected media can act as direct exposure pathways for chemicals or can be the source of chemicals to other media. The migration pathways to soil, subsurface air, outdoor air, groundwater, surface water, sediment, and wetlands are discussed in the following subsections.

6.2.1. Soil

Potential migration pathways for contaminated soil at Parcel E-2 are (1) erosion by surface water runoff, (2) erosion by wind and suspension of chemicals to outdoor air, (3) leaching to groundwater, and (4) volatilization of chemicals to outdoor air. During previous investigations at Parcel E-2, concentrations of metals, PCBs, pesticides, SVOCs, petroleum hydrocarbons, and VOCs have been detected and quantified in surface soil (0 to 2 feet bgs), shallow subsurface soil (2 to 10 feet bgs), and deep subsurface soil samples (greater than 10 feet bgs). The location of contaminated soil in the Landfill Area, East Adjacent Area, and Panhandle Area are discussed below.

6.2.1.1. Landfill Area Soil

At the Landfill Area, solid waste is intermixed with soil to a maximum depth of 14 feet below msl and varies from 10 to 25 feet thick. As shown on Figure 6-1, beneath the landfill waste lies native soil consisting of Bay Mud and sand deposits. Within the landfill boundaries, subsurface soil that is commingled with waste materials has been potentially affected by chemicals at the landfill.

As discussed in Section 4.5.3, soil characterization data within the Landfill Area were used to assess the approximate lateral and vertical extent (relative to the landfill waste volume) of chemical concentrations greater than the RIEC. Nearly all of the chemicals detected at concentrations greater than the RIEC in Landfill Area soil were of a limited extent relative to the overall waste volume. Several chemicals, such as PCBs and SVOCs, were detected throughout a large portion of the Landfill Area at concentrations exceeding the RIEC, but at concentrations that were not indicative of hot spots (defined as chemical concentrations that are 100 times greater than the corresponding RIEC). Six locations within the Landfill Area contained concentrations of either PCBs or SVOCs that were greater than 100 times the RIEC; however, these locations were isolated relative to the overall waste volume and were situated at relatively deep depths (between 8 and 16 feet bgs). The data set, when considered in its entirety, demonstrates that lesser quantities of hazardous wastes are present in the landfill as compared with municipal-type waste and construction debris.

6.2.1.2. East Adjacent and Panhandle Area Soil

In the East Adjacent Area and Panhandle Area, isolated areas of waste are present within soil and rock fill. As discussed in Section 6.1, waste types include construction debris and industrial waste. During investigations in the East Adjacent and Panhandle Areas, concentrations of metals, PCBs, pesticides, SVOCs, furans, and petroleum hydrocarbons have been detected and quantified in soil samples collected from all depths sampled (maximum depth of 41.25 feet bgs). Soil contamination is more widely distributed in the Panhandle Area and the shallow zones (0 to 10 feet bgs) of the East Adjacent Area. Historic aerial photographs indicate that fill material was placed in these areas during shipyard operations from the mid-1950s to 1974, as opposed to deep soil (greater than 10 feet bgs) within the East Adjacent Area, which consists of either natural sedimentary deposits or fill material placed during expansion of the shipyard in the early 1940s. The heterogeneous chemical distribution in the Panhandle Area and the shallow zones of the East Adjacent Area indicates that fill material placed at Parcel E-2 during shipyard operations may contain unacceptable levels of contamination.

Removal actions in the East Adjacent Area and the Panhandle Area at Parcel E-2 have removed PCB- and metals-contaminated soil through excavation, thus decreasing the spatial distribution of chemicals in soil in these areas within Parcel E-2. In particular, excavation of the PCB Hot Spot Area within the East Adjacent Area removed near-surface PCB contamination. This near-surface PCB contamination is believed to be the source of elevated concentrations of PCBs detected in ambient air during the Phase II and III ambient air monitoring and during construction of the interim landfill cap (see Section 3.7). However, as discussed in Section 4.5.3.1, elevated concentrations of PCBs indicative of potential hot spots remain along the western and southwestern boundaries of the PCB Hot Spot Area excavation. The Navy initiated a follow-on removal action to address the potential hot spots in this area (Navy, 2010); this follow-on removal action was initiated in March 2010 and is projected to be completed in 2011.

6.2.2. Subsurface Air (Gas from the Landfill)

Primary migration pathways for contaminated subsurface air emanating from the landfill are (1) horizontal migration of landfill gas through fill material or preferential pathways such as utility corridors; (2) migration of landfill gas into subsurface void spaces (e.g., utility vaults, below grade structures, etc.); and (3) vertical migration of landfill gas through soil or cracks in nearby building floors (Figure 6-1) to the air above.

Subsurface air partially comprises landfill gas generated by the decomposition of organic waste in the Parcel E-2 Landfill. Potentially explosive concentrations of landfill gas (primarily methane), as well as NMOCs, were detected north of the landfill boundary during previous investigations. The gas had migrated through the heterogeneous fill and waste material in the northern portion of the landfill and into the adjacent non-Navy property. To address the landfill gas concerns on the northern boundary, a gas extraction and control system was installed to remove landfill gas from beneath non-Navy property and control future migration of landfill gas north of the landfill boundary. Landfill gas has also been shown to accumulate within monitoring wells and other subsurface vaults at concentrations that may exceed 25 percent of the LEL, thus posing a hazard to site workers. Ongoing monitoring is performed to demonstrate that landfill gas migration is being effectively controlled along the northern boundary, and to verify that landfill gas accumulation within monitoring wells and other subsurface vaults do not pose a hazard to site workers.

6.2.3. Outdoor Air

As presented in the wind speed and direction map (Figure 1-5), the prevailing winds at Parcel E-2 are from the west and move across Parcel E-2 eastward toward Parcel E and the San Francisco Bay. Migration of chemicals in soil through erosion by wind and suspension of chemicals in air can potentially cause outdoor air to be considered an affected media.

As discussed in Section 3.7, previous air monitoring activities performed at Parcel E-2 have indicated that chemical concentrations in air at Parcel E-2 are similar to bay area regional air quality monitoring results, with only minor differences observed for most chemicals investigated. The most notable exceptions are past detections of PCBs in the southeast portion of Parcel E-2. These PCB detections were associated with dust generated during past construction activities; specifically, the sandblast waste fixation project and landfill cap construction. As discussed in Section 6.2.1, surface soil with elevated PCB concentrations has been removed under a removal action; therefore, PCBs in outdoor air should be less likely in the future. Dust control measures and perimeter air monitoring is performed during intrusive construction activities at Parcel E-2. Such control practices have been proven to effectively control this migration pathway and will continue to be implemented during future remedial activities. As an additional precaution, the HHRA evaluates potential exposure to contaminated soil that may migrate to outdoor air through wind suspension and volatilization.

6.2.4. Groundwater

Primary potential migration pathways for contaminated groundwater include migration and discharge of A-aquifer groundwater into San Francisco Bay and wetlands and migration of A-aquifer groundwater (including the saturated waste layer) into the uppermost B-aquifer. Additional potential migration pathways include groundwater entering storm drains, sanitary sewers, and horizontal utility trench bedding materials located below the water table. It should be noted, however, that the limited number of subsurface utilities located within Parcel E-2 serves to minimize the effect of these pathways.

Groundwater contamination has been confirmed based on sampling results for Parcel E-2 in both the A-aquifer and uppermost B-aquifer. The lateral and vertical extent of chemicals in groundwater has been defined across most of Parcel E-2 through a series of investigations and the ongoing groundwater monitoring program. The extent of chemicals in groundwater, however, is not completely defined along the Parcel E-2 shoreline. This uncertainty is highest at the PCB Hot Spot Area, where, prior to the removal action, concentrations of PCBs, SVOCs, and TPH consistently exceeded RIECs. Groundwater monitoring resumed in 2007, following completion of the excavation activities, and was supplemented with data from a focused investigation performed along the Parcel E-2 shoreline in 2008. The PCB Hot Spot Area removal action performed near the Parcel E-2 shoreline included removal of a large amount of the soil PCB source and is likely to result in reduced dissolved concentrations in Parcel E-2 aquifers. The same removal action also likely reduced source concentrations of other chemicals (e.g. SVOCs and TPH) detected in the area. Data collected from temporary and replacement wells in the vicinity of the PCB Hot Spot Area, although not extensive, suggest that attenuation is occurring.

As described in Section 2, nearly the entire Parcel E-2 Landfill is underlain by Bay Mud, which generally acts as a confining unit that inhibits groundwater flow, and hence vertical migration of chemicals, between the A- and the B-aquifers. Migration of chemicals between the A-aquifer and uppermost B-aquifer is a potential pathway in areas where Bay Mud is absent (i.e., the northwest corner of Parcel E-2) or very thin. The A-aquifer and uppermost B-aquifer are interconnected in the northwest corner of Parcel E-2; however, the vertical groundwater flow potential is upward in this area. Also, the presence of laterally continuous layers of silt and clay within B-aquifer sediments throughout Parcel E-2 serve to hydraulically isolate the uppermost B-aquifer (which is interconnected with the A-aquifer) from the lower portions of the B-aquifer (Figure 6-1).

The major chemical groups detected in groundwater at the Landfill Area, East Adjacent Area, and Panhandle Area include VOCs, SVOCs, metals, TPH, pesticides, PCBs, and anions (such as cyanide). Groundwater sampling results indicate that the concentrations and extent of contamination in the uppermost B-aquifer is less than observed in the A-aquifer due to the hydrogeologic and geologic characteristics (presence of Bay Mud) across most of Parcel E-2 (Figure 6-1). Overall, the number of detected chemicals and the magnitude of the concentrations detected in both aquifers have declined between 1990 and 2007.

6.2.4.1. Landfill Area Groundwater

Groundwater is in direct contact with solid waste and contaminated soil across most of the Landfill Area. As a result, groundwater has been affected by leaching of chemicals from solid waste and contaminated soil. To a lesser degree, precipitation infiltration in areas not currently covered by the interim landfill cap also contributes to leaching of chemicals in soil into the A-aquifer. As expected, groundwater concentrations in the Landfill Area are elevated due to its close proximity to solid waste.

6.2.4.2. Groundwater in Panhandle and East Adjacent Areas

Areas with waste and contaminated soil in the Panhandle and East Adjacent Areas are a potential source of groundwater contamination. Where groundwater is in contact with industrial waste, such as metal debris and oily waste, chemical concentrations in groundwater may be elevated because of leaching of contamination from the waste. However, waste in the East Adjacent and Panhandle Areas consists primarily of inert construction debris, with lesser quantities of putrescible construction debris (including wood). These types of construction debris are not expected to generate leachate that would create potential risks to human health or the environment.

6.2.5. Surface Water

Surface water runoff (including runoff from freshwater wetlands located in the Panhandle Area) can be contaminated by leaching from contaminated soil or through surface erosion and subsequent suspension of contaminated soil in surface water. Primary potential migration pathways are migration and discharge of contaminated surface water and sediments into the intertidal zone (including tidal and emergent saltwater wetlands) and San Francisco Bay. Surface water discharge from the Parcel E-2 Landfill is managed in accordance with the SWDMP (MARRS and MACTEC, 2009b). The Parcel E-2 stormwater program involves quarterly visual observations of non-stormwater discharge, stormwater sampling and analysis, monthly visual observations of stormwater discharge, and an annual comprehensive evaluation of site compliance with the SWDMP. Stormwater monitoring locations and BMPs that are used at Parcel E-2 to control stormwater discharges are shown on Figure 2-22. Results to date indicate no incidents of noncompliance at Parcel E-2 except in isolated locations where BMPs require modification to better control erosion and sediment transport.

6.2.6. Sediment

Sediments in Parcel E-2 are located in the Shoreline Area bordering San Francisco Bay, as shown on Figure 6-1. For the purposes of this report, the extent of sediment is limited to this intertidal zone. The Shoreline Characterization Technical Memorandum (Appendix G to this RI/FS Report) identified contaminated sediment along the length of the intertidal Shoreline Area. Primary potential migration pathways for the Shoreline Area are erosion by surface water runoff or tidal action. Details on the nature and extent of sediment contamination in the Shoreline Area are described in Appendix G.

6.2.7. Wetlands

Wetland areas at Parcel E-2 (Figure 6-1) are potentially contaminated by (1) leaching of chemicals from contaminated soil, (2) surface erosion and suspension of contaminated soil in surface water runoff feeding into the wetlands, and (3) seepage of contaminated groundwater from the A-aquifer groundwater into tidal and emergent saltwater wetland areas located in the intertidal zone. Primary potential migration pathways are migration and discharge of contaminated surface water and sediments from the wetland areas into San Francisco Bay.

Given their sensitive ecological nature, investigation activities within wetland areas have been limited. Available characterization data from wetland areas located in the Panhandle and East Adjacent Areas were summarized as part of the soil evaluation (Section 4), and data from wetland areas located in the Shoreline Area were summarized as part of the shoreline characterization (Appendix G).

6.3. EXPOSURE POINTS, EXPOSURE ROUTES, AND RECEPTORS

Figure 6-3 shows the conceptual site model flow chart for Parcel E-2. Based on this model, exposure pathways, exposure points, and potential receptors were identified for each contaminated medium (soil, subsurface air, groundwater, surface water, sediments, and wetlands). Outdoor air (referred to as air and dust on Figure 6-3) does not present a primary exposure pathway because, as discussed in Section 6.2.3, dust mitigation and removal actions are adequately controlling airborne dust contamination. However, as an additional precaution, the HHRA evaluates potential exposure to contaminated soil that may migrate to outdoor air through wind suspension and volatilization.

The following subsections summarize the primary exposure pathways, including exposure route and primary and secondary receptors.

6.3.1. Soil

On-site human receptors (such as future site visitors, trespassers, and site workers) can be exposed to contaminated soil primarily through dermal contact and, to a lesser extent, ingestion. However, site workers are anticipated to have proper training and are assumed to use proper protection for working with contaminated soil, which would greatly minimize exposure. Terrestrial ecological receptors could be exposed to solid waste and contaminated soil through ingestion.

6.3.2. Subsurface Air

As discussed in Section 6.2.2, on- and off-site human receptors could potentially be exposed to contaminated subsurface air emanating from the landfill through soil or cracks in buildings. In addition to the toxicity aspects of landfill gas, explosive concentrations of methane gas can accumulate in buildings and confined spaces creating an explosion risk. Potential on-site human receptors include future site users and workers, and potential human off-site receptors include area residents and workers. However, on-site workers are anticipated to have proper training and are assumed to use proper monitoring and protective equipment for working with contaminated subsurface air, which would greatly minimize exposure.

As evidenced by ongoing monitoring, the landfill gas control system is effectively preventing off-site migration of gas on the northern boundary, and no buildings are currently constructed within Parcel E-2.

6.3.3. Groundwater

The primary exposure route for groundwater is off-site exposure to extracted groundwater from the B-aquifer in residential and commercial wells. As a result, off-site human receptors (people with residential and commercial wells) could be exposed to contaminated groundwater in the uppermost B-aquifer through ingestion, dermal contact, and inhalation.

Based on EPA groundwater classification criteria, most of the Parcel E-2 A-aquifer is a potential source of drinking water (Class II groundwater, see Section 2.2.6); a characterization that warrants further analysis. Appendix I includes an evaluation of various site-specific factors (SSFs) to determine if site-specific conditions affect the potential for the A-aquifer groundwater at Parcel E-2 to be used as a drinking water source. As outlined in Appendix I, a range of SSFs make use of A-aquifer groundwater for water supply extremely unlikely. In addition, the RWQCB determined that the A-aquifer at HPS is not suitable or potentially suitable as a municipal or domestic water supply, and meets exemption criteria in SWRCB Resolution 88-63 (SWRCB, 1988) and RWQCB Resolution 89-39 (RWQCB, 2003c). As a result, chemicals in A-aquifer groundwater are less likely to affect human receptors through direct ingestion, dermal contact, or inhalation. On-site workers could be exposed to A-aquifer groundwater if trenching activities occur to a depth where groundwater is encountered or if their work involves management of leachate. It is presumed, however, that these on-site workers will have proper training and are assumed to use proper protection for working with contaminated groundwater, which would greatly minimize exposure.

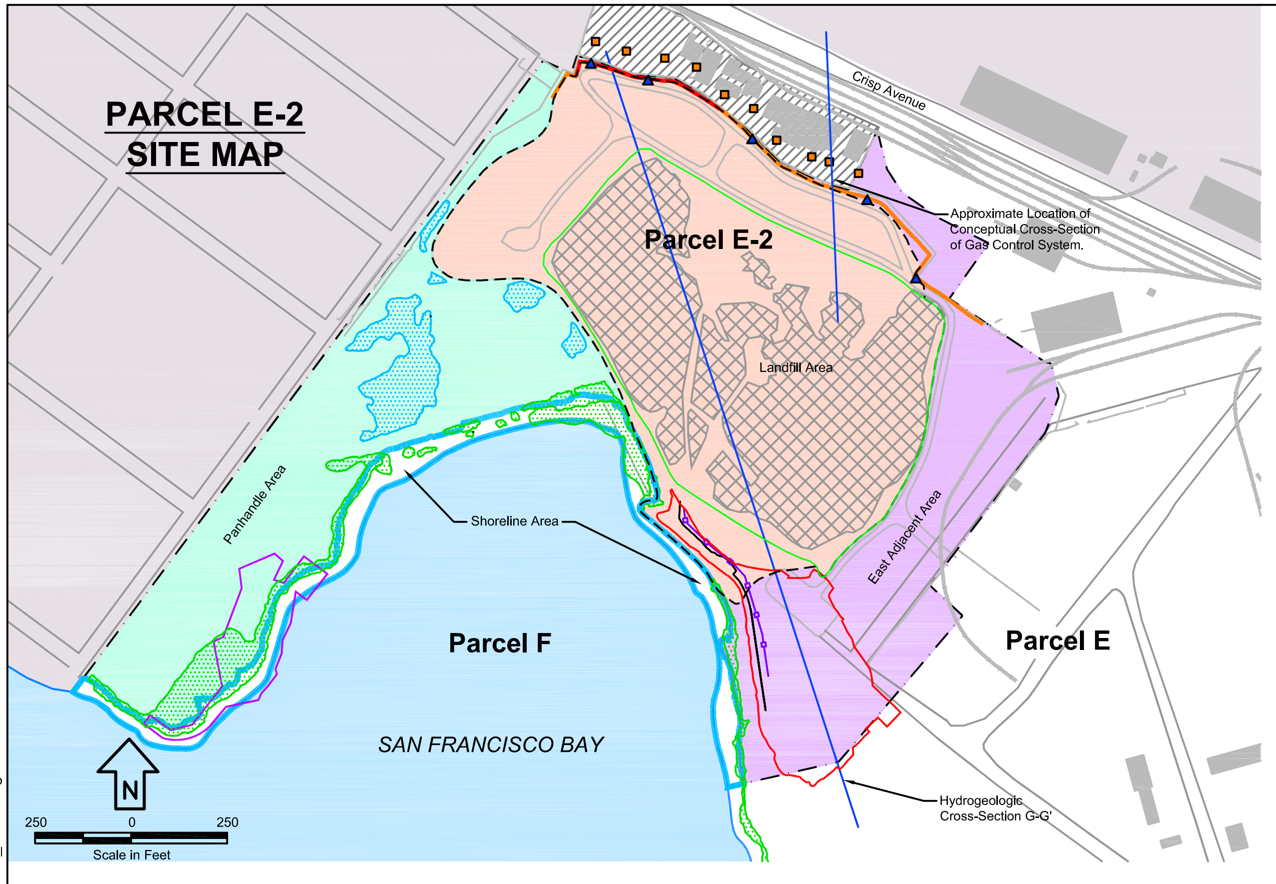
6.3.4. Surface Water and Sediment

Chemicals mobilized through surface water runoff and contaminated groundwater have the potential to migrate to the intertidal zone (including sediments and wetlands) and San Francisco Bay, thus affecting human and ecological receptors in those environments. On-site human receptors (such as visitors, trespassers, and future site workers) could be exposed to contaminated surface water and sediment through ingestion and dermal contact. However, site workers are anticipated to have proper training and are assumed to use proper protection for working with contaminated soil, which would greatly minimize exposure. Potential off-site human receptors, such as people swimming, could also be exposed to contaminated surface water through dermal contact and ingestion. From an ecological standpoint, off-site aquatic wildlife can be exposed to contaminated surface water runoff through ingestion and bioconcentration. Secondary receptors are humans who consume fish from a contaminated habitat.

6.3.5. Wetlands

Ecological receptors in the wetlands area are the wildlife found in a wetland ecosystem. Similar to terrestrial ecological receptors elsewhere at Parcel E-2, these receptors would be exposed to chemicals through ingestion.

Figures



LEGEND

- Burn Area
- Parcel E–2 Boundary
- Parcel Boundary
- Estimate of Solid Waste Extent
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Shoreline Area
- Freshwater Wetlands
- Tidal Wetlands
- Non–Navy Property
- UCSF Compound
- Building
- San Francisco Bay
- Road
- Gravel Road

Removal Actions

- Interim Landfill Cap
- Metal Slag Area (2007 excavation limit)[a]
- PCB Hot Spot Area Excavation (2007 excavation limit)[a]

Groundwater Extraction System

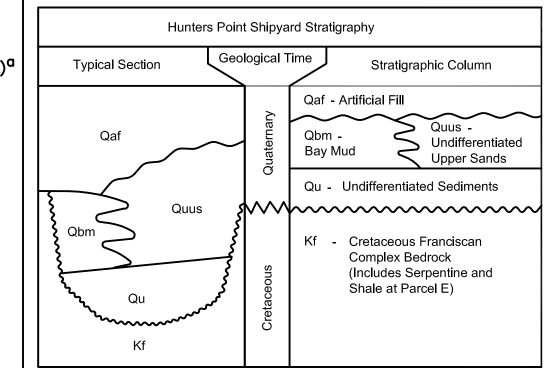
- Sheet–Pile Wall
- Extraction Trench

Interim Landfill Gas Control System

- Extraction Well
- Passive Vent
- HDPE Barrier Wall
- Grouted Section of HDPE Barrier Wall That Can Be Used For Extraction

Notes:
HDPE = high density polyethylene
PCB = polychlorinated biphenyls
UCSF = University of California, San Francisco

[a]Post–excavation boundaries in PCB Hot Spot Area and Metal Slag Area are consistent with information presented in final removal action completion reports (Tetra Tech EC Inc., 2007a and 2007b).

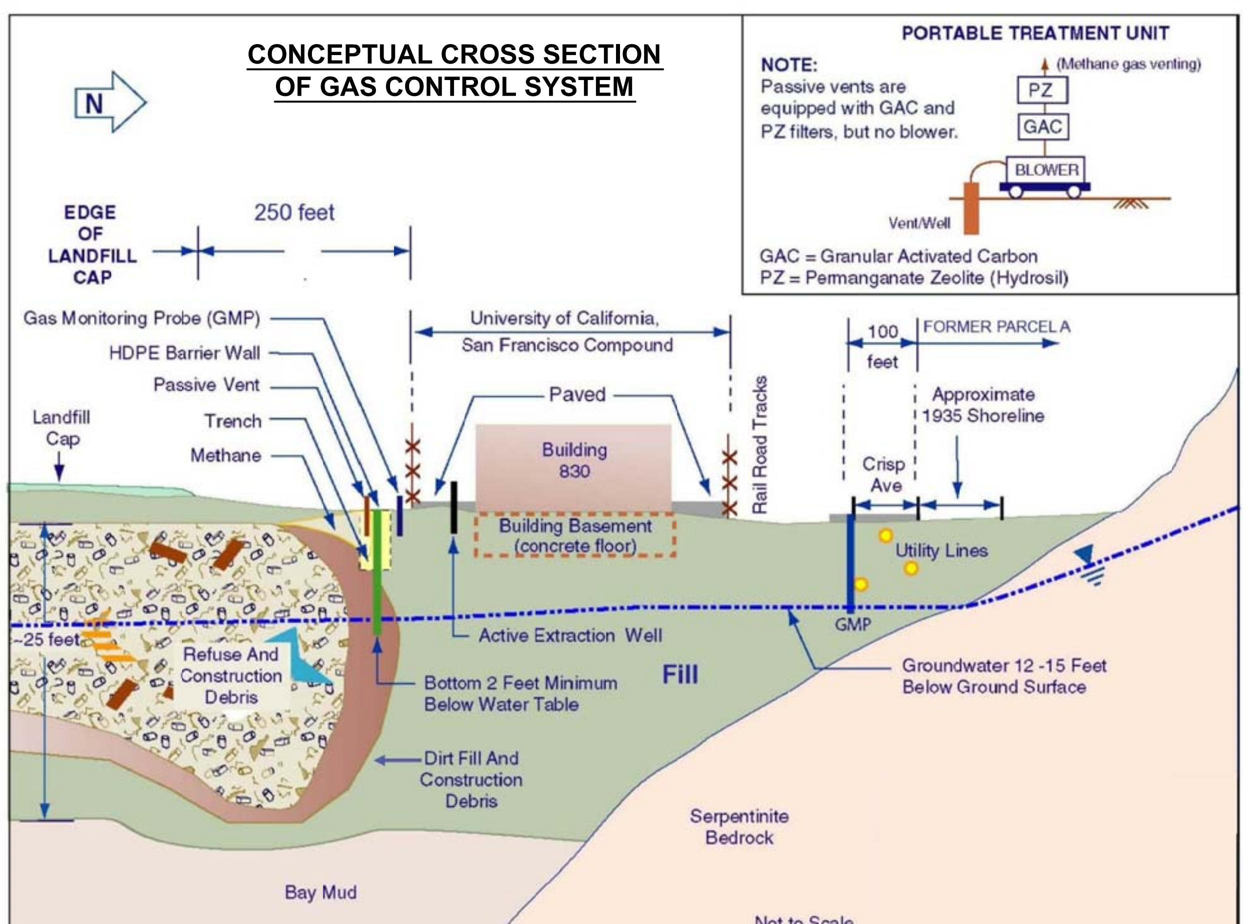


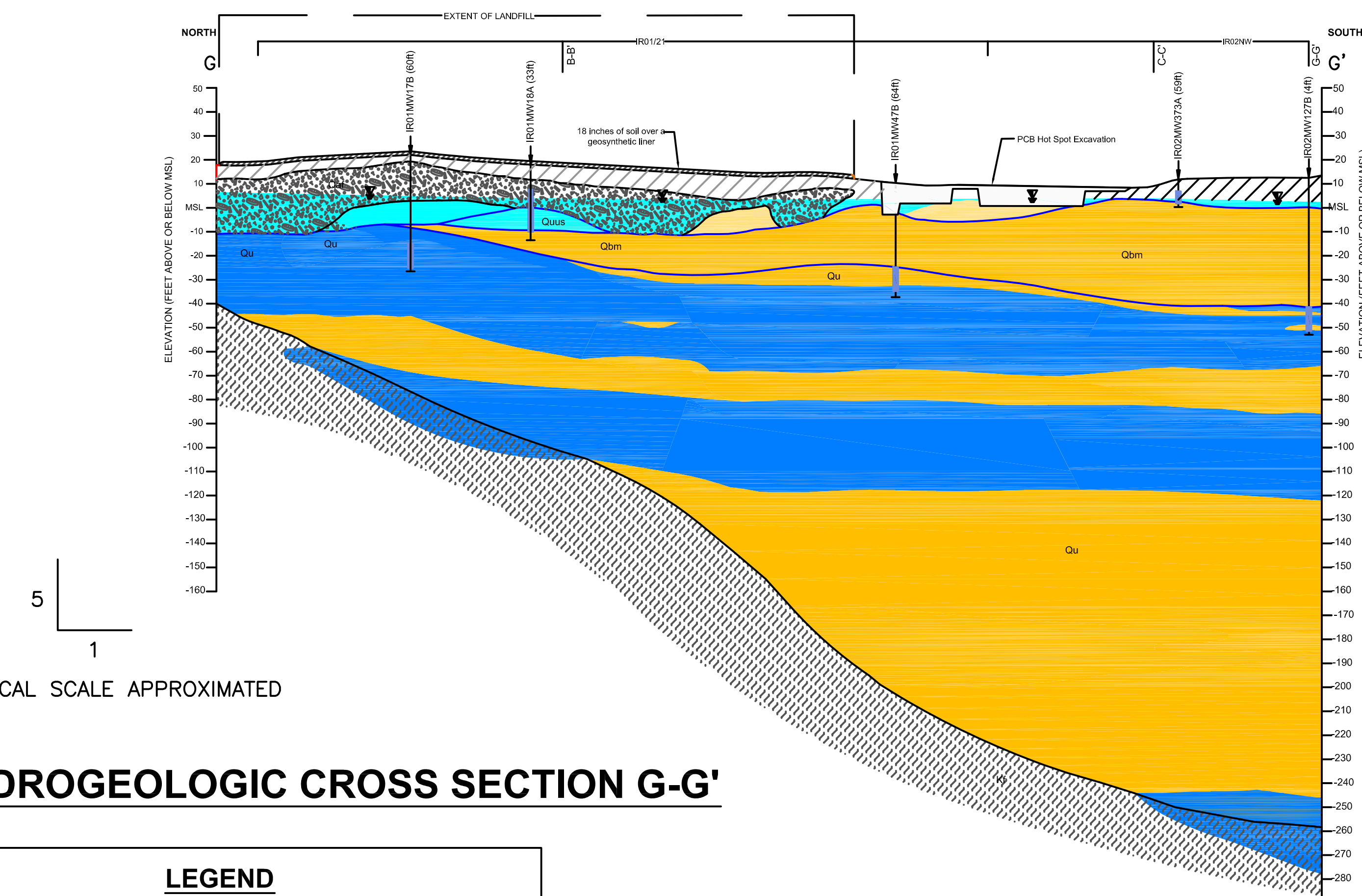
Notes:

1. These cross–sections represent one interpretation of the shallow subsurface along the corresponding line; alternate interpretations are possible.
2. Borings have been projected onto the lines of section. The projection of borings' lithologies may cause graphical distortions of geological features.
3. Bedrock and sediment contact is based on lithological logs and a bedrock surface map.
4. Lithologic information removed for simplicity; refer to Figure 2–9.

Reference:

Tetra Tech EM, Inc. 2004 Final Parcel E Groundwater Summary Report, Phase III Groundwater Data Gaps Investigation, Hunters Point Shipyard. May





HYDROGEOLOGIC CROSS SECTION G-G'

LEGEND

- Landfill Cap
- (Disatance Projected to Cross Section) Monitoring Well/Soil Boring Location.
- Well Screen
- A–Aquifer Zone Water Table February 2002
- Formation Contact (dashed where inferred)
- Intersection location of cross sections
- A–Aquifer Zone
- B–Aquifer Zone
- Aquitard Zone
- Qaf Low Permeable Zone based on Lithology
- Debris
- Unsaturated Artificial Fill
- Bedrock

ERRG Engineering/Remediation Resources Group, Inc.

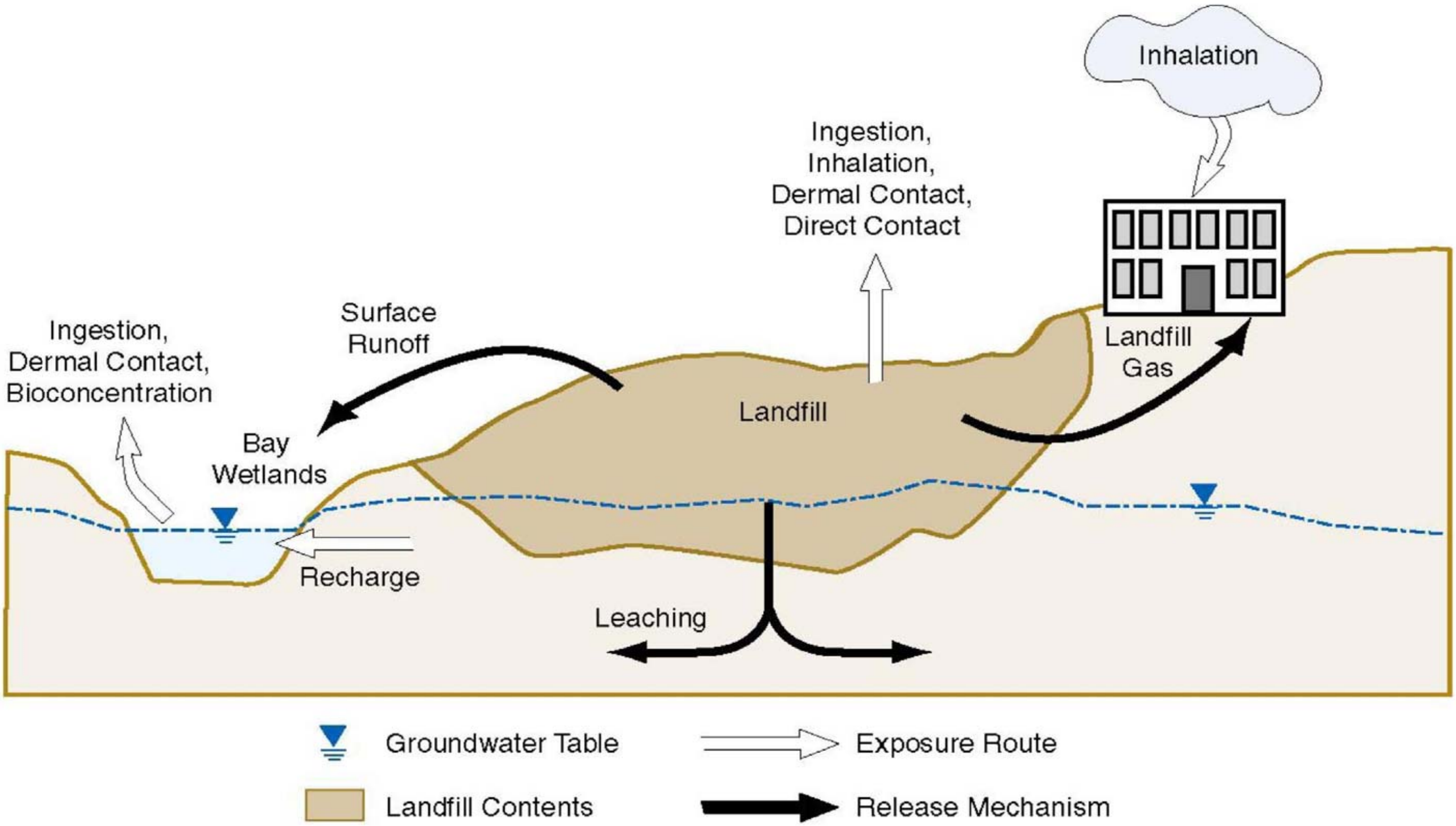
Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 6-1
CONCEPTUAL SITE MODEL

Remedial Investigation/Feasibility Study for Parcel E-2

P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Timeline\HPS-timeline\dwg\HPS-6-1-Conceptual Site Model_Rev1.dwg



Modified from U.S. Environmental Protection Agency, 1991. "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municpal Landfill Sites" (EPA/540/P-91/001)

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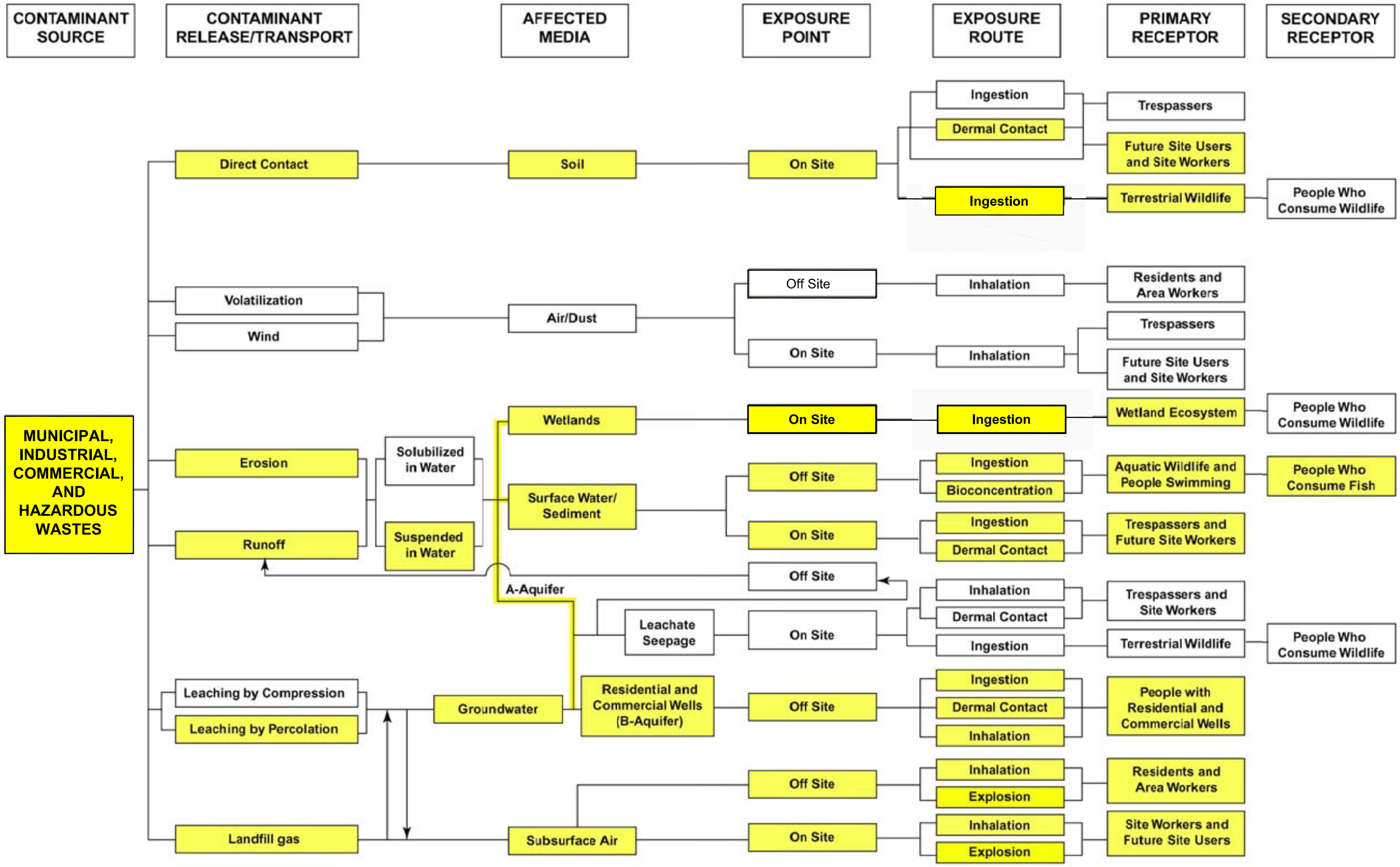
Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 6-2
SCHEMATIC OF POTENTIAL MIGRATION PATHWAYS

Remedial Investigation/Feasibility Study for Parcel E-2



Primary exposure pathways are highlighted in yellow.

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U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 6-3

CONCEPTUAL SITE MODEL FLOW CHART

Remedial Investigation/Feasibility Study for Parcel E-2

Modified from U.S. Environmental Protection Agency, 1991. "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municpal Landfill Sites" (EPA/540/P-91/001)

P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps & Drawings\GIS\Projects\Landfill\Timeline\HPS-timeline\dwg Fig. 6-2 & 6-3.dwg

Section 7. Risk Assessment

This section evaluates potential risks to human health and the environment from exposure to chemicals in soil, intertidal sediment, and groundwater at Parcel E-2. Previous risk evaluations for human exposure to subsurface air emanating from the Parcel E-2 Landfill were discussed in Section 4.1.2.2. Previous and ongoing risk evaluation for ecological exposure to surface water runoff from the Parcel E-2 Landfill was discussed in Section 3.9.3. In the risk assessment process, the chemicals that might contribute to human health and ecological risk (referred to as COPCs for the HHRA and COPECs for the SLERA performed in this report) are evaluated quantitatively. As a result, chemicals of concern (COCs) for human health and chemicals of ecological concern (COECs) for wildlife are identified and numerical remediation goals are identified for each COC and COEC.

As discussed in Section 1.4, use of the landfill presumptive remedy allows for qualitative risk evaluations instead of more detailed quantitative evaluations. While the Landfill Area meets the criteria for application of the containment presumptive remedy, the adjacent areas (the Panhandle Area, East Adjacent Area, and Shoreline Area) do not meet these criteria. In addition, as part of the FS process, the Navy elected to evaluate excavation and disposal technologies as a point of comparison with the containment presumption. Considering these factors, a quantitative HHRA to support the remedial alternative evaluation in this RI/FS Report has been conducted. As an added benefit, results of the quantitative HHRA are used to validate application of the containment presumption, as outlined in EPA guidance (EPA, 1993a, 1993b, and 1996, provided in Appendix H to this RI/FS Report). Specifically, the HHRA results are used to determine whether risks attributed to waste within the Landfill Area are "low-level" and therefore consistent with EPA's definition of municipal-type waste.

An initial BERA was conducted during the Parcel E RI, and follow-up validation study was performed in 2000. As discussed in Section 3.5, this effort resulted in identifying COPECs and acceptable soil concentration thresholds (PSCs) for terrestrial receptors. PSCs are HPS-specific, risk-based criteria developed for the protection of terrestrial ecological receptors. PSCs were originally derived using 12 collocated soil and tissue samples collected from within Parcels E and E-2 (TtEMI and LFR, 2000b). The PSCs used site-specific prey tissue data to represent actual bioavailability of chemicals at the site rather than relying on bioaccumulation factors published in the scientific literature.

Since the derivation of the original PSCs, Parcel E-2 was split from Parcel E and additional soil data were collected during the SDGI. The current data set was evaluated to validate the COPEC list used in the previous BERA for terrestrial receptors. As a result of this effort, additional chemicals were identified as COPECs and PSCs were calculated for these additional chemicals. In light of the updated information, the Navy updated the previous ecological assessments by performing a SLERA for onshore ecological receptors (Appendix L) using the updated PSCs and surface soil data set. In addition, the Navy prepared a SLERA to evaluate potential risks to offshore ecological receptors from exposure to intertidal sediment. The offshore SLERA was prepared in conjunction with the Shoreline Characterization Technical Memorandum, and is included as Appendix G to this report.

Section 7.1 discusses the HHRA for the Landfill Area, Panhandle Area, and East Adjacent Area. Section 7.2 discusses the onshore and shoreline SLERAs, which evaluate potential risks to terrestrial receptors at Parcel E-2. Section 7.3 summarizes the ERA for exposure of ecological receptors to contaminated groundwater.

7.1. HUMAN HEALTH RISK ASSESSMENT

The following subsections discuss the HHRA methodology and results and present the remediation goals for the COCs identified in the HHRA.

7.1.1. Human Health Risk Assessment Methodology

The objectives of the revised HHRA were to:

- Estimate potential human health risks associated with potential future land use scenarios
- Identify environmental media and chemicals that pose the primary health concerns
- Identify environmental media and chemicals that are likely to pose little or no threat to human health
- Provide a foundation for assessing the need for further response actions

An HHRA for the Parcel E-2 Landfill was originally conducted in 1997 as part of the Parcel E RI Report (TtEMI, LFR, and U&A, 1997). However, in 2004, the Navy decided to complete the RI/FS for the Parcel E-2 area separately from the other Parcel E sites to accelerate the CERCLA process. This HHRA includes data from the original RI investigation, with additional data generated from the SDGI and NDGI (TtEMI, 2005c and 2004f). In addition, groundwater data collected through October 2007 as part of the BGMP are included in this HHRA. Lastly, revisions were made to the HHRA based on agreements between the Navy and the BCT during 2003 and 2004.

The HHRA calculated cancer risks and noncancer hazards from exposure to COPCs in all affected environmental media for each pathway identified as potentially complete. Risks and hazards were calculated for reasonable maximum exposure (RME); that is, the maximum exposure that is reasonably expected to occur at a site. Appendix K details the HHRA methodology and results. This section provides an overview of the exposure scenarios and pathways evaluated in the HHRA and summarizes the results of the HHRA. In addition, remediation goals are presented for the COCs for Parcel E-2 based on the results of the HHRA.

7.1.1.1. Exposure Scenarios and Pathways

Table 7-1 presents an exposure matrix that summarizes the exposure pathways identified as potentially complete for the receptors identified for each exposure scenario discussed below.

Soil Exposure: The 2010 amended "Hunters Point Shipyard Redevelopment Plan" outlines the planned reuses for Parcel E-2 (SFRA, 2010). Figure 1-15 shows the specific planned reuse for Parcel E-2. According to the 2010 amended Redevelopment Plan, most of the planned reuse for Parcel E-2 is open space. A small area (about 0.42 acres) in the East Adjacent Area is designated as part of the Shipyard South Multi-Use District, which includes potential recreational, industrial, and residential reuse (SFRA, 2010). As discussed in Section 1.8 and documented in the previous versions of the RI/FS Report published in 2007 and 2009, land uses other than open space were not anticipated prior to publication of the 2010 amended Redevelopment Plan. While preparing this Final RI/FS Report, the Navy evaluated the uncertainty of the risk assessment findings for the 0.42-acre area in the East Adjacent Area designated as part of the Shipyard South Multi-Use District. As discussed in Section 7.1.2.1, the Navy determined that no updates to the risk assessment were required to make an informed risk management decision for this area.

For this reason, the planned reuse exposure scenario evaluated for Parcel E-2 is limited to open space reuse. Open space reuse is associated with a recreational exposure scenario. Based on the planned reuses at Parcel E-2, the following potential human receptors were selected for evaluation in this revised baseline HHRA:

- Recreational user (adult and child)
- Construction worker (adult)

Although not directly associated with a specific planned reuse for Parcel E-2, a construction worker scenario was also identified as a potential human receptor because it is possible that exposure to site chemicals could occur as a result of excavation and trenching activities.

For the purpose of the HHRA, Parcel E-2 was divided into 0.5-acre exposure areas (approximately 150 feet by 150 feet). The characterization of health risks is based only on exposure areas with analytical data for soil. The 0.5-acre exposure area was selected by the HPS BCT and the city of San Francisco as a reasonable estimate for a light industrial lot in the San Francisco Bay area. Therefore, in the HHRA, recreational and construction worker exposures are assumed to occur over an area equivalent to the

0.5-acre exposure area, and risks were evaluated for each exposure area. This HHRA refers to each 0.5-acre exposure area at Parcel E-2 as an “open space grid.” For purposes of the HHRA, each grid was assigned a unique identification number, referred to as the “grid number.”

Risks from exposure to soil were evaluated for each grid for which sampling data are available and the sampling locations have not been subject to removal actions. Exposure to soil was assessed for two depth intervals in the HHRA: surface soil (0 to 2 feet bgs) and subsurface soil (0 to 10 feet bgs). Exposure to recreational visitors was assumed to be limited to the shallower surface soil depth interval, based on the assumption that intrusive activities are not expected in areas planned for open space reuse. Construction workers were assumed to be exposed to the deeper subsurface soil depth interval, based on the assumption that construction workers will be involved in intrusive soil excavation activities. Risks were not characterized for grids that were not sampled.

Groundwater Exposure: Based on the reasonably anticipated reuse of Parcel E-2 as open space, groundwater pathways are not considered complete for recreational visitors, which are the only receptors associated with reasonably anticipated reuse. Results of the evaluation of beneficial uses of groundwater at Parcel E-2 (see Section 2.2.6 and Appendix I) indicate the following:

- The A-aquifer at HPS was previously determined by RWQCB to be unsuitable as a potential source of drinking water (RWQCB, 2003c). The A-aquifer at Parcel E-2 is also considered to be unsuitable as a potential drinking water source based on federal groundwater classification criteria and an evaluation of SSFs.
- The B-aquifer at Parcel E-2 has moderate potential to be used as a drinking water source, based on available TDS data and an evaluation of SSFs.

Because the potential beneficial use of groundwater in the B-aquifer at HPS includes drinking water, the HHRA includes an evaluation of B-aquifer groundwater for domestic use. The potential for vertical hydraulic communication between the A- and B-aquifers exists in some areas at Parcel E-2 (see Section 2.2); therefore, evaluation of exposure from domestic use of the B-aquifer uses both B-aquifer and A-aquifer data.

As discussed, the A-aquifer is unsuitable as a drinking water source; however, because the depth to the A-aquifer at Parcel E-2 is relatively shallow (an average of 8.6 feet bgs based on water level measurements at Parcel E-2 from November 2006 to March 2008), construction workers were also assumed to be exposed to groundwater in the A-aquifer during trenching activities. Exposure pathways identified as potentially complete for the construction worker are dermal contact with A-aquifer groundwater and inhalation of volatile chemicals released from A-aquifer groundwater to outdoor air in a construction trench.

7.1.1.2. Total and Incremental Risks for Soil Exposure

Both total and incremental risks were evaluated for exposure to surface and subsurface soil at Parcel E-2. For the total risk evaluation, all chemicals detected or estimated (J-qualified) in one or more samples of surface and subsurface soil were included as COPCs regardless of concentration, except for the essential nutrients calcium, magnesium, potassium, and sodium. The total risk evaluation provides an estimate of the risks posed by all chemicals at the site, including those present at concentrations at or below background levels. For the incremental risk evaluation, the essential nutrients and metals with maximum measured concentrations below HPALs were excluded as COPCs. The incremental risk evaluation provides an estimate of risks posed by all chemicals at the site, except those that do not exceed background levels.

Nondetected results for COPCs in soil were incorporated in the total and incremental risk evaluations by use of a proxy concentration. Details on this approach are provided in Section K4.0 of Appendix K. Appendix K also discusses the potential effect on the HHRA of the methods used to treat nondetected results.

7.1.2. Human Health Risk Assessment Results

This subsection summarizes the results of the total and incremental risk evaluations for soil.

7.1.2.1. HHRA Results for Recreational Exposure Scenario

For the recreational exposure scenario, risks from exposure to COPCs in soil were assessed for surface soil (0 to 2 feet bgs). Figure 7-1 summarizes the grid-specific total risk results for surface soil, based on the reasonably anticipated reuse of Parcel E-2 as open space. Figure 7-2 summarizes the grid-specific incremental risk results for surface soil. In both Figures 7-1 and 7-2, the results for each grid are shown relative to the cancer risk threshold of 1E-06, highest "segregated" noncancer hazard index (HI) threshold of 1, and HPS RBC for lead (155 mg/kg) for recreational receptors. The "segregated" HI identifies the value as it relates to a specific target organ or systems. For the recreational exposure scenario (0 to 2 feet bgs), the specific calculated total and incremental cancer risk and noncancer HI results for each grid are listed in Tables 7-2 and 7-3, respectively.

Sixty-seven grids at Parcel E-2 have sampling data for surface soil. Of these 67 grids, the total recreational risk for 63 of the grids exceeds the cancer risk threshold of 1E-06, and the highest segregated HI for 16 of the grids exceeds the threshold HI of 1. Based on the results of the incremental risk evaluation for recreational visitors, 39 grids at Parcel E-2 exceed the cancer risk threshold of 1E-06, and 16 grids exceed the noncancer threshold HI of 1. Under both the total and incremental risk evaluations, 26 grids exceed the RBC for lead for recreational visitors.

Tables 7-4 and 7-5 present a risk characterization analysis of total and incremental risk for the recreational scenario, respectively, of the grids for which the cancer risk exceeds 1E-06, the highest segregated HI exceeds 1, or the exposure point concentration (EPC) for lead exceeds the recreational RBC for lead. For each of these grids, the tables identify the COCs and present their contribution to the calculated total risks and hazards for each potentially complete exposure pathway.

Grids AK29 and AK30 are located in the 0.42-acre area in the East Adjacent Area designated as part of the Shipyard South Multi-Use District. As shown on Figures 7-1 and 7-2, the total and incremental risk estimates at grids AK29 and AK30 (1) exceed the cancer risk threshold of 1E-06, (2) exceed the noncancer threshold HI of 1, and (3) exceed the RBC for lead for recreational visitors. Accordingly, the FS portion of this report evaluates remedial actions to address this potential risk to future recreational users. Because a risk evaluation using more conservative exposure factors associated with potential residential reuse would have reached the same conclusion, no updates to the risk assessment were required to make an informed risk management decision in the 0.42-acre area in the East Adjacent Area designated as part of the Shipyard South Multi-Use District.

Both total and segregated noncancer HI results are shown in Tables 7-2 through 7-5. The total HI represents the cumulative HI, regardless of the specific target organs or systems within the body affected by the COPCs. However, noncancer health effects may not be cumulative if the COPCs affect different target organs or systems within the body. Therefore, the HHRA segregates the HI by target organ or system; the potential for noncancer health effects exists only if the highest total segregated HI for a target organ or system exceeds 1. For each exposure area, the highest calculated segregated HI is shown in Tables 7-2 through 7-5.

The chemicals listed in the table on the following page were identified as COCs in at least one grid, based on the results of the total and incremental risk evaluation for soil for the recreational exposure scenario. As shown in the table on the following page, the COCs for the recreational scenario are the same between the total and incremental risk evaluations.

7.1.2.2. HHRA Results for Construction Worker Exposure Scenario

For the construction worker exposure scenario, risks from exposure to COPCs in soil were assessed for subsurface soil (0 to 10 feet bgs). Figure 7-3 summarizes the grid-specific total risk results for subsurface soil for the construction worker. Figure 7-4 summarizes the grid-specific incremental risk results for subsurface soil. The results for each grid are shown relative to the cancer risk threshold of 1E-06, highest segregated noncancer HI threshold of 1, and HPS RBC for lead (800 mg/kg) for construction workers. For the construction worker exposure scenario (0 to 10 feet bgs), Tables 7-6 and 7-7, respectively, present the specific calculated total and incremental cancer risk and noncancer HI results for each grid.

Exposure Scenario	Chemicals of Concern: Surface Soil (0 to 2 feet bgs), Total Risk	Chemicals of Concern: Surface Soil (0 to 2 feet bgs), Incremental Risk
Recreational [a]	Antimony	Antimony
	Aroclor-1242	Aroclor-1242
	Aroclor-1248	Aroclor-1248
	Aroclor-1254	Aroclor-1254
	Aroclor-1260	Aroclor-1260
	Arsenic	Arsenic
	Benzo(a)anthracene	Benzo(a)anthracene
	Benzo(a)pyrene	Benzo(a)pyrene
	Benzo(b)fluoranthene	Benzo(b)fluoranthene
	Benzo(k)fluoranthene	Benzo(k)fluoranthene
	Dieldrin	Dieldrin
	Heptachlor epoxide	Heptachlor epoxide
	Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene
	Lead	Lead
	Total PCBs (non-dioxin)	Total PCBs (non-dioxin)

Note:

a COCs identified for this exposure scenario are based on the reasonably anticipated reuse for Parcel E-2 as open space.

Eighty-two grids at Parcel E-2 have sampling data for subsurface soil. Of these 82 grids, the total construction worker risk for 78 of the grids exceeds the cancer risk threshold of 1E-06, and the highest segregated HI for 37 of the grids exceeds the threshold HI of 1. Based on the results of the incremental risk evaluation, 49 grids at Parcel E-2 exceed the cancer risk threshold of 1E-06, and 36 grids exceed the noncancer threshold HI of 1. Under both the total and incremental risk evaluations, 20 grids exceed the RBC for lead for the construction worker.

Table 7-8 summarizes the risk analysis results from exposure to A-aquifer groundwater for construction workers in a trench. Incremental risks were not assessed for groundwater for the construction worker scenario because this scenario is not associated with a specific planned reuse for Parcel E-2. For the construction worker exposure scenario (0 to 10 feet bgs), Tables 7-9 and 7-10 present the total and incremental risk characterization analyses, respectively, for the grids in which the cancer risk exceeds 1E-06, the highest segregated HI exceeds 1, or the EPC for lead exceeds the construction worker RBC for lead. For each of these grids, the tables identify the COCs and present their contribution to the calculated total risks and hazards for each potentially complete exposure pathway.

Similar to the approach used to assess noncancer hazards for the recreational scenario (see Section 7.1.2.1), Tables 7-6 through 7-10 present both total and segregated noncancer HI results for the construction worker scenario for each exposure area. These tables show the highest segregated HI by target organ or system; the potential for noncancer health effects exists only if the highest total segregated HI for a target organ or system exceeds 1.

The chemicals listed in the table below were identified as COCs for soil in at least one grid, based on the results of the total and incremental risk evaluation for soil for the construction worker exposure scenario or were identified as COCs for the A-aquifer. As shown in the table on the following page, the soil COCs for the construction worker scenario are the same between the total and incremental risk evaluations.

Exposure Scenario	Chemicals of Concern		
	Subsurface Soil (0 to 10 feet bgs), Total Risk	Subsurface Soil (0 to 10 feet bgs), Incremental Risk	Groundwater, A-aquifer
Construction Worker[a]	4,4-DDT Antimony Aroclor-1016 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260 Arsenic Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Cadmium Copper Dibenz(a,h)anthracene Dieldrin Dioxin (TEQ) Heptachlor epoxide Indeno(1,2,3-cd)pyrene Iron Lead Manganese Naphthalene Total PCBs (non-dioxin) Vanadium	4,4-DDT Antimony Aroclor-1016 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260 Arsenic Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Cadmium Copper Dibenz(a,h)anthracene Dieldrin Dioxin (TEQ) Heptachlor epoxide Indeno(1,2,3-cd)pyrene Iron Lead Manganese Naphthalene Total PCBs (non-dioxin) Vanadium	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Lead

Notes:

a The construction worker exposure scenario is not associated with a specific planned reuse for Parcel E-2.

TEQ Toxicity equivalent quotient

7.1.2.3. HHRA Results for Domestic Use of Groundwater

As discussed in Section 7.1.1.1, domestic use of groundwater was evaluated for the B-aquifer. As a conservative approach, only total risks were assessed for exposure to groundwater. Similar to the approach used for the total risk evaluation for soil, all chemicals detected or estimated (J-qualified) in one or more samples of groundwater were included as COPCs regardless of concentration, except for the essential nutrients calcium, magnesium, potassium, and sodium. Nondetected results for COPCs in groundwater were excluded from the HHRA (see Section K4.1 of Appendix K).

Table 7-11 summarizes the risk results for domestic use of the B-aquifer. As indicated in Section 7.1.1.1, data from the A-aquifer was also used in the domestic use evaluation of the B-aquifer to account for potential hydraulic communication between the two aquifers in some areas of Parcel E-2. Table 7-11 presents a risk characterization analysis for those COCs for which the cancer risk exceeds 1E-06 or the highest segregated HI exceeds 1 for the groundwater exposure pathways associated with domestic use of the B-aquifer. Table 7-11 identifies the groundwater COCs associated with the domestic use scenario and the percent contribution of each COC to the total cancer risk and HI calculated for the B-aquifer. Table 7-12 presents the results of the groundwater evaluation for lead. For evaluation purposes, lead concentrations in groundwater were compared with the California regulatory action level for lead of 15 µg/L. The following chemicals are identified as COCs based on domestic use of groundwater.

Exposure Scenario	Chemicals of Concern for B-Aquifer Groundwater	
Domestic Use[a]	1,1-Dichloroethane[b]	Chloroform
	1,2,3-Trichloropropane	Chromium VI
	1,2-Dichloroethane	Chrysene [b]
	1,4-Dichlorobenzene [b]	Dibenz(a,h)anthracene [b]
	4-Nitrophenol [b]	Dieldrin [b]
	Aroclor-1016 [b]	Heptachlor [b]
	Aroclor-1242 [b]	Heptachlor epoxide [b]
	Aroclor-1254 [b]	Heptachlor epoxide A [b]
	Aroclor-1260 [b]	Heptachlor epoxide B [b]
	Arsenic	Indeno(1,2,3-cd)pyrene
	Benzene	Iron [b]
	Benzo(a)anthracene [b]	Lead [b]
	Benzo(a)pyrene [b]	Methylene Chloride
	Benzo(b)fluoranthene	Naphthalene
	Benzo(k)fluoranthene [b]	Tetrachloroethene
	Beta-BHC [b]	Thallium [b]
	Bis(2-ethylhexyl)phthalate [b]	Trichloroethene [b]
	Carbon tetrachloride	Vinyl chloride [b]

Notes:

a As discussed in Section 7.1.1.1, data from the A-aquifer were also used in the domestic use evaluation to account for potential communication between the A- and B-aquifers in some areas of Parcel E-2.

b This chemical is only a COC if risks are calculated using B- and A-aquifer data. That is, if risks are calculated based solely on B-aquifer data (assumes vertical hydraulic communication does not result in migration of chemicals from the B-aquifer to the A-aquifer), this chemical would not be identified as a COC.

BHC benzene hexachloride

HGALs have been developed for groundwater in the A-aquifer at HPS and are likely applicable for groundwater in the B-aquifer. However, data for inorganic chemicals in the B-aquifer were not compared with HGALs in the HHRA as a conservative approach and incremental risks were not assessed for the groundwater domestic use evaluation.

7.1.3. Remediation Goals

Remediation goals were developed for the COCs identified for soil and groundwater, using the methodology described in the subsections below. The development of remediation goals for soil was limited to COCs identified for soil based on the incremental risk evaluation results, which excludes the risks posed by metals at concentrations below ambient levels, in accordance with EPA guidance.

7.1.3.1. Soil

Remediation goals for COCs in soil were selected based on a comparison of the COC-specific RBC, laboratory practical quantitation limit (PQL) based on standard EPA analytical methods, and HPAL (inorganic chemicals only). For each COC, the highest of these three concentrations was selected as the remediation goal. With the exception of lead, exposure scenario-specific RBCs were calculated based on a target cancer risk level of 1E-06 and target noncancer HI of 1. This is consistent with the exposure pathways and assumptions described in Appendix K that were used to assess human health risks. For lead, the exposure scenario-specific RBCs were based on modeled blood lead concentrations, as discussed in Section K7.4 of Appendix K. Table 7-13 presents the remediation goals for COCs in soil.

Remediation goals for recreational visitors and construction workers for one inorganic chemical (arsenic) were based on the HPAL for arsenic. Comparison of the HPAL for arsenic with the RBCs for arsenic for recreational visitors and construction workers shows that the ambient level for arsenic in soil exceeds the respective RBCs. Section K9.1 of Appendix K addresses the risks and hazards associated with exposure to metals in soil at ambient levels at HPS.

7.1.3.2. Groundwater

Remediation goals for COCs in groundwater in the A- and B-aquifers, as identified by the HHRA, are shown in Tables 7-14 and 7-15. Development of the remediation goals for groundwater was based on consideration of chemical-specific ARARs (that is, state of California and federal MCLs), exposure-scenario-specific RBCs, laboratory PQLs, and HGALs (for metals only). Chemical-specific ARARs are discussed further and identified in Section 10.1.1. Chemical-specific ARARs were only considered in the development of the remediation goals for the B-aquifer; no ARARs are available to address the construction worker scenario assessed for the A-aquifer. When available, project-required quantitation limits from the BGMP (CE2-Kleinfelder Joint Venture, 2009c) were used as PQLs; otherwise, PQLs were based on standard EPA analytical methods. Exposure scenario-specific concentrations based on a target cancer risk of 1E-06 and a target noncancer HI of 1 were used as RBCs for groundwater; these RBCs were calculated consistent with the exposure pathways and assumptions used in the HHRA (Appendix K) to assess risks from exposure to groundwater. The RBCs for COCs in the A-aquifer were based on dermal contact and inhalation for a construction worker exposure scenario. For the B-aquifer, the RBCs were based on ingestion and inhalation during household use for a residential domestic use scenario.

For organic COCs, the chemical-specific ARAR is used as the remediation goal, if applicable, and when available. In the absence of chemical-specific ARARs, the chemical-specific RBC is used as the remediation goal for organic COCs. However, the remediation goal defaults to the laboratory PQL if the ARAR- or RBC-based concentration is lower than the PQL, because the ARAR or RBC would not be detectable at concentrations below the PQL. For inorganic chemicals, this same hierarchy applies for selection of remediation goals, except that the HGAL (metals only) is selected as the remediation goal if it exceeds either the chemical-specific ARAR or the RBC and is greater than the laboratory PQL. HGALs for two inorganic COCs (arsenic and thallium) in the B-aquifer exceed their respective RBCs. These exceedances show that domestic use exposure to ambient levels of arsenic and thallium in the B-aquifer is associated with a cancer risk that exceeds 1E-06 and a noncancer HI that exceeds 1, respectively. However, MCLs are available for both of these chemicals; therefore, remediation goals for arsenic and thallium are based on MCLs.

7.1.4. Sample Locations with Chemical Concentrations Exceeding Remediation Goals

A list of soil sampling locations with chemical concentrations exceeding remediation goals was compiled to identify the locations at Parcel E-2 for which remedial action is required, based on its reasonably anticipated reuse as open space. Table 7-16 shows the soil sampling locations with concentrations of COCs exceeding remediation goals for surface soil.

7.2. SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENTS

A SLERA was conducted to update the previous ecological assessments at Parcel E-2. A summary of the Parcel E-2 SLERA (also referred to as the "onshore" SLERA) is presented in Section 7.2.1. A separate SLERA was performed to evaluate potential risk to aquatic wildlife exposed to intertidal sediment within the Shoreline Area of Parcel E-2. The shoreline SLERA is presented in Appendix G and is summarized in Section 7.2.2.

7.2.1. Onshore Screening-Level Ecological Risk Assessment

The SLERA was necessitated by the collection of additional data during the SDGI which resulted in the identification of new COPECs and calculation of corresponding PSCs. The objective of the SLERA is to determine the potential for significant risk to terrestrial receptors exposed to soil from 0 to 3 feet bgs at Parcel E-2 within the onshore area.

This subsection provides an overview of the findings of the onshore SLERA. A complete copy of the assessment is provided in Appendix L. The SLERA was performed in accordance with the EPA and Navy guidance (EPA, 1997; Navy, 1999).

7.2.1.1. Summary of SLERA Process

EPA guidance separates the ERA process into eight steps, three of which apply to the current ecological assessment at Parcel E-2:

- Step 1: Screening-level problem formulation and evaluation of ecological effects
- Step 2: Screening-level preliminary exposure estimate and risk calculation
- Step 3: BERA problem formulation

The substantive elements of Steps 1 and 2 constitute the SLERA. The onshore SLERA extends into the initial phase of Step 3, which corresponds to Step 3a "Refinement of Conservative Exposure Assumptions" of the Navy's ERA process. Step 3a focuses on refining the list of COPECs based on comparison with HPALs. Further refinement of the ecological risks, using food chain modeling for birds and mammals, was not considered necessary given several factors:

- The onshore environment at Parcel E-2 has undergone several phases of ecological risk assessment, including a baseline ERA (1997) and a validation study (1999). These past studies are discussed in Section 3.5 of this RI/FS Report. As discussed in Section L1 of Appendix L, this SLERA was necessitated by the collection of additional data during a soil data gaps investigation in 2002, which resulted in the identification of new COPECs and the calculation of corresponding PSCs.
- The purpose of including quantitative risk assessments in the Parcel E-2 RI/FS was, as discussed in Section 1.4, to identify areas that require remedial action to protect human health and the environment.
- The site conceptual model, as discussed in Sections 6.2.1 and 6.3.1, identifies solid waste throughout the Landfill Area and heterogeneous soil contamination throughout the Panhandle and East Adjacent Areas, as posing a potential risk to terrestrial ecological receptors.

The SLERA performed for Parcel E-2 (through Step 3a) conservatively depicts the potential ecological risk in the onshore environment at Parcel E-2. Considering the heterogeneous contaminant distribution within the Landfill, Panhandle, and East Adjacent Areas, this conservative evaluation meets the overall goal of the RI/FS process and, when coupled with the results of the human health risk assessment, provides an adequate basis for developing a focused set of remedial alternatives for Parcel E-2.

As described in detail in Appendix L, the Parcel E-2 onshore SLERA characterizes the risk to terrestrial ecological receptors exposed to near-surface soil at Parcel E-2, inland of the narrow "intertidal zone" along the Parcel E-2 shoreline. The intertidal zone is the area that is marked between the low- and high-water lines. The onshore SLERA focused on birds and mammals that were identified in previous ecological studies at Parcel E and E-2.

The onshore SLERA performed for this report used all soil data collected from 0 to 3 feet bgs from all locations within Parcel E-2. A simple HQ approach was used to determine if any COPECs, on a sample-by-sample basis, present a potential risk at the site. The HQ is the ratio of the maximum detected soil concentration for a given COPEC to its calculated PSC. The HQ approach is typical of Step 2 of a SLERA and has been used in other HPS ERAs. Any HQ greater than 1.0 is considered to indicate potential risk. In the risk characterization step, chemicals were also compared with HPALs, where appropriate.

7.2.1.2. Onshore SLERA Results

The estimation of potential risk to terrestrial receptors exposed to COPECs was calculated for each of the three subareas (the Landfill Area, East Adjacent Area, and Panhandle Area) of Parcel E-2. In these areas, some potentially toxic chemicals were detected at concentrations exceeding HPALs and PSCs, indicating a potentially significant risk to terrestrial receptors. Based on concentrations exceeding PSCs (HQ greater than 1) and HPALs, the following chemicals (or groups of chemicals) pose a potential threat to birds and mammals exposed to soil in one or more onshore study areas of Parcel E-2:

- Metals: cadmium, copper, lead, manganese, mercury, nickel, vanadium, and zinc;
- Total DDT: sum of detected concentrations of 2.4’-DDT and 4,4’-DDT;
- Total PCBs: sum of detected concentrations of all Aroclor compounds; and
- Total high molecular weight (HMW) polycyclic aromatic hydrocarbons (PAHs): sum of detected concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene.

Figure 7-5 shows the locations where soil concentrations exceeded PSCs for any chemical within Parcel E-2. Table 7-17 presents a statistical summary of samples analyzed as part of the SLERA. HPALs, PSCs, maximum concentrations in soil, and the number of samples exceeding respective PSCs are shown in Table 7-17.

7.2.2. Shoreline Screening-Level Ecological Risk Assessment

A shoreline investigation was performed in 2002 as part of the SDGI, because the Parcel F validation study hypothesized that metals and PCBs along the shoreline were a source of contamination to Parcel F sediments. Intertidal sediment data collected during the shoreline investigation were evaluated in the Shoreline Characterization Technical Memorandum (Appendix G to this report), which included a shoreline SLERA. The objective of the shoreline SLERA was to evaluate whether contamination at suspected source areas along the shoreline of Parcel E-2 poses an unacceptable risk to ecological receptors exposed to sediment at the Shoreline Area.

This subsection provides an overview of the findings of the shoreline SLERA. A complete copy of the shoreline SLERA is provided as Appendix G to this report. The SLERA was performed in accordance with the EPA and Navy guidance (EPA, 1997; Navy, 1999).

7.2.2.1. Summary of Shoreline SLERA Process

The shoreline SLERA characterized risk to ecological receptors exposed to the narrow intertidal zone of Parcels E and E-2. The intertidal zone is the area that is marked between the low- and high-water lines. The SLERA focuses on benthic invertebrates, birds, and mammals that forage along the Parcels E and E-2 shoreline in the intertidal zone. To meet the objective of the SLERA, concentrations of chemicals in surface and subsurface sediment samples collected from the Parcels E and E-2 shoreline were screened against toxicological benchmarks for invertebrates, birds, and mammals.

The shoreline SLERA evaluated surface shoreline sediment samples (collected from 0 to 0.5 feet bgs) and subsurface sediment samples (collected from 2.0 to 2.5 feet bgs). All chemicals detected in sediment samples from the shoreline area were screened to identify COPECs, except for essential mineral nutrients such as sodium, chloride, potassium, phosphorous, magnesium, and calcium. COPECs for benthic invertebrates were identified as those chemicals with concentrations exceeding their effects range-median (ER-M) values (Long and Morgan, 1991; National Oceanic and Atmospheric Administration, 1993).

In the evaluation of birds and mammals, chemicals were screened using food chain modeling against TRV. Selected COPECs also were compared against HPALs (PRC, 1995a) and ambient sediment concentrations of selected chemicals in San Francisco Bay (RWQCB, 1998 and 2003a). Similar to the onshore SLERA, HQs were calculated on a sample-by-sample basis for each COPEC. In the shoreline SLERA, the HQ is defined as the ratio of EPCs in surface sediment to ER-M values. All detected inorganic and organic chemicals in surface and subsurface sediment were evaluated in the toxicological screen by evaluating the HQ. Chemicals with HQs greater than 1.0 were considered COPECs for benthic invertebrates.

7.2.2.2. Shoreline SLERA Results for Benthic Invertebrates

Benthic invertebrates are at risk from exposure to PCBs in surface and subsurface sediment along the Parcels E and E-2 shoreline. Benthic invertebrates in surface and subsurface sediment may be adversely affected by exposure to copper, lead, zinc, and DDTs. In subsurface sediment, mercury may pose an additional risk to benthic invertebrates. Appendix G of this RI/FS Report presents the complete results for benthic invertebrates in the shoreline SLERA.

7.2.2.3. Shoreline SLERA Results for Birds and Mammals

Significant risk to birds is indicated only for the willet exposed to PCBs. No significant risk to either the surf scoter or the red-tailed hawk was indicated by the food-chain modeling. Other chemicals for which potential risk to birds is suggested included cadmium, copper, lead, mercury, PCBs, total DDTs, and dieldrin.

Birds and mammals are at risk from exposure to PCBs in surface and subsurface sediment along the Parcels E and E-2 shoreline. Ingestion of sediment and prey that contain cadmium, copper, molybdenum, zinc, and PCBs may pose a risk to the house mouse. The greatest significant risk (high TRV HQ) for mammals was indicated for PCBs ingested by the house mouse. Appendix G of this RI/FS Report presents the complete results for birds and mammals in the shoreline SLERA.

7.3. ECOLOGICAL RISK ASSESSMENT FOR EXPOSURE TO GROUNDWATER

A screening-level assessment of ecological risk to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2 is provided in Appendix M. The assessment consists of the following general steps:

- Aquatic evaluation criteria were selected based on surface water quality criteria (Basin Plan Table 3-3; California Toxics Rule [CTR]; National Recommended Water Quality Criteria [NRWQC]; and National Ambient Water Quality Criteria [NAWQC]). All of these standards apply to surface water; none of them applies to groundwater. Therefore, these potential ARARs for surface water would be applied to the surface water at the interface of the A-aquifer groundwater, but would not be used to set cleanup standards for in-situ A-aquifer groundwater at Parcel E-2.
- The Navy developed trigger levels for various inland locations to ensure surface water quality criteria are not exceeded if groundwater at Parcel E-2 discharges to the Bay. The trigger levels are intended to serve as conservative comparison values for groundwater to indicate when additional evaluation may be necessary. The development of the trigger levels was initially performed in the Parcel D FS, and has also been applied at HPS Parcels B and D (now referred to as Parcels D-1, D-2, G, and UC-1). The development of the trigger levels is discussed in Attachment M-1.
- Chemical concentrations in groundwater were screened against the assigned aquatic evaluation criteria, mainly comprised of saltwater aquatic criteria, to identify COPECs for surface water quality.
- Site-specific data for select COPECs were then evaluated against trigger levels, where appropriate, to confirm if the COPECs posed a potential risk to aquatic receptors requiring remedial option analysis.

Based on concentrations exceeding trigger levels (as adjusted based on HGALs), the following chemicals (or groups of chemicals) pose a potential threat to aquatic wildlife through exposure to surface water impacted by contaminated groundwater at Parcel E-2:

- Metals: copper, lead, and zinc;
- Anions: un-ionized ammonia, sulfide, and cyanide;
- Total PCBs: sum of detected concentrations of all Aroclor compounds; and
- Total TPH: sum of detected concentrations of all TPH ranges (gasoline-range, diesel-range, and motor-oil range).

Figure 7-6 shows the locations where groundwater concentrations exceeded their respective trigger levels. Table 7-18 summarizes the specific COPECs at the locations identified on Figure 7-6.

Figures

Legend

- ★ Lead Concentration > 155 mg/kg (Recreational RBC)
- No Data
- Highest Segregated Hazard Index > 1
- Cancer Risk > 1E-06
- Cancer Risk ≤ 1E-06
- Parcel E-2 Boundary
- Estimate of Solid Waste Extent
- Interim Landfill Cap Extent
- Non-Navy Property
- Shoreline Area
- Building
- San Francisco Bay
- Road
- Gravel Road
- Landfill Area
- East Adjacent Area
- Panhandle Area

Notes:

A 150-foot by 150-foot exposure area (open space grid) is used to evaluate risks associated with recreational exposures.

bgs = below ground surface
mg/kg = milligram per kilogram
RBC = risk-based concentration

N

250 0 250

Scale in Feet

ERRG ENGINEERING/REMEDIATION RESOURCES GROUP, INC.

Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 7-1
TOTAL RISK - SURFACE SOIL (0 TO 2 FEET BGS) RECREATIONAL EXPOSURE SCENARIO

Remedial Investigation/Feasibility Study for Parcel E-2

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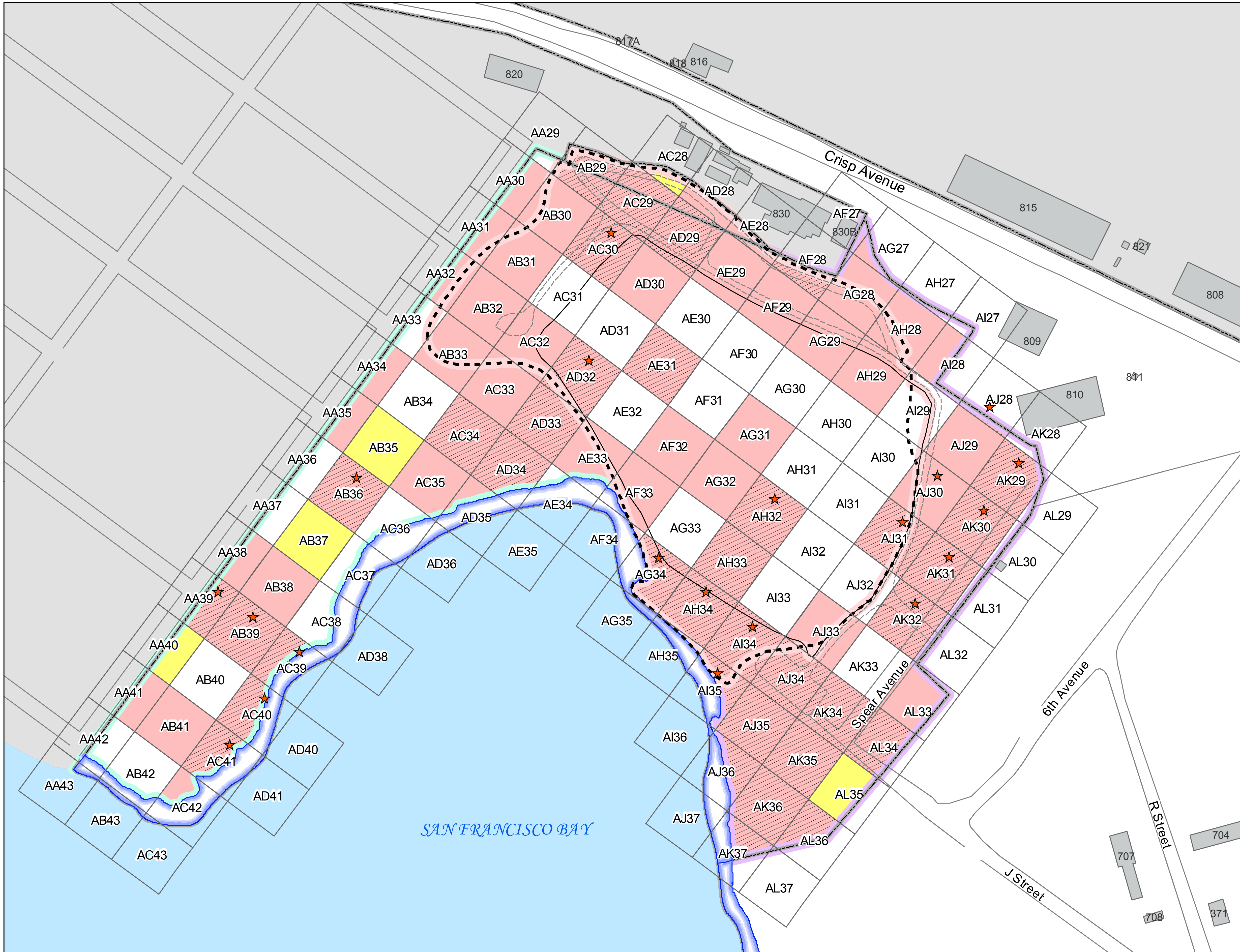


Legend

- Lead Concentration > 800 mg/kg (Industrial RBC)
- No Data
- Highest Segregrated Hazard Index > 1
- Cancer Risk > 1E-06
- Cancer Risk ≤ 1E-06
- Parcel E-2 Boundary
- Estimate of Solid Waste Extent
- Interim Landfill Cap Extent
- Non-Navy Property
- Shoreline Area
- Building
- San Francisco Bay
- Road
- Gravel Road
- Landfill Area
- East Adjacent Area
- Panhandle Area

Notes:

A 150-foot by 150-foot exposure area (open space grid) is used to evaluate risks associated with recreational exposures.

bgs = below ground surface
mg/kg = milligram per kilogram
RBC = risk-based concentration

N

250 0 250

Scale in Feet

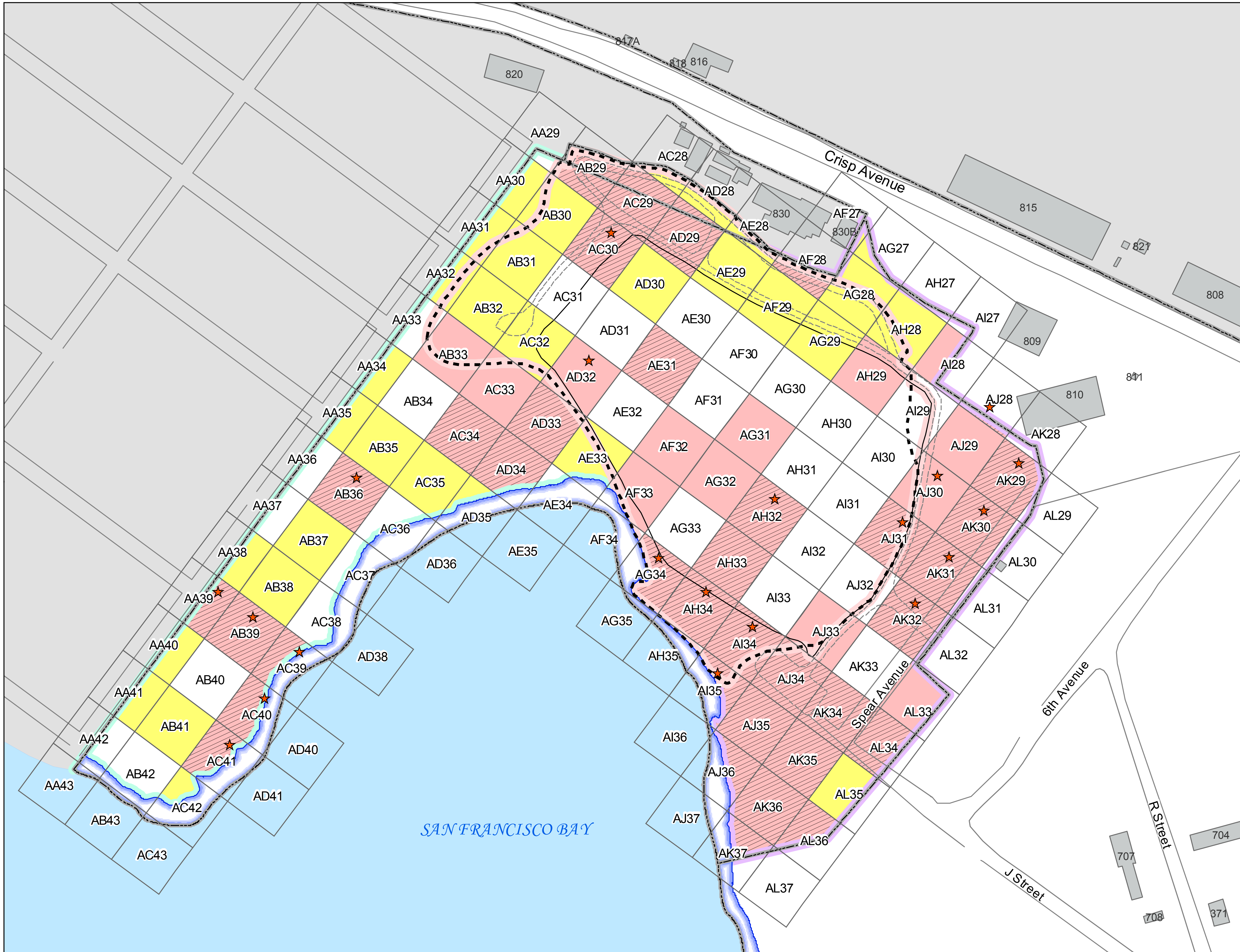
ERRG ENGINEERING/REMEDIATION RESOURCES GROUP, INC.

Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 7-3
TOTAL RISK - SUBSURFACE SOIL (0 TO 10 FEET BGS) CONSTRUCTION WORKER EXPOSURE SCENARIO

Remedial Investigation/Feasibility Study for Parcel E-2

\\Con-fs01\Projects\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\HHRA\TotalRisk-SB-0-10.mxd



Legend

- ★ Lead Concentration > 800 mg/kg (Industrial RBC)
- No Data
- Highest Segregrated Hazard Index > 1
- Cancer Risk > 1E-06
- Cancer Risk ≤ 1E-06
- Parcel E-2 Boundary
- Estimate of Solid Waste Extent
- Interim Landfill Cap Extent
- Non-Navy Property
- Shoreline Area
- Building
- San Francisco Bay
- Road
- Gravel Road
- Landfill Area
- East Adjacent Area
- Panhandle Area

Notes:

A 150-foot by 150-foot exposure area (open space grid) is used to evaluate risks associated with recreational exposures.

bgs = below ground surface
mg/kg = milligram per kilogram
RBC = risk-based concentration

N

250 0 250

Scale in Feet

ERRG ENGINEERING/REMEDIATION RESOURCES GROUP, INC.

Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 7-4
INCREMENTAL RISK - SUBSURFACE SOIL (0 TO 10 FEET BGS) CONSTRUCTION WORKER EXPOSURE SCENARIO

Remedial Investigation/Feasibility Study for Parcel E-2

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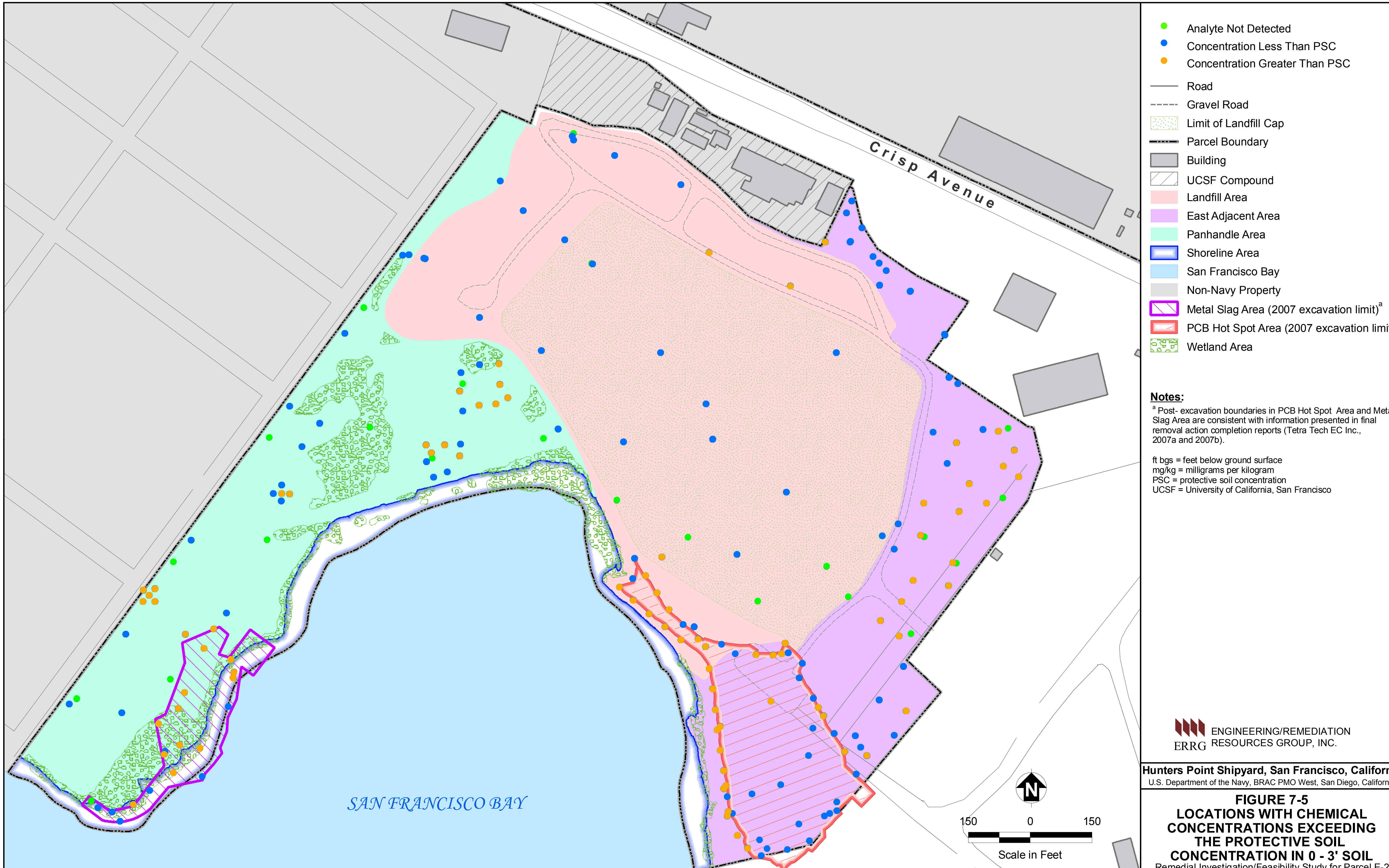

Notes:

[a] Post- excavation boundaries in PCB Hot Spot Area and Metal Slag Area are consistent with information presented in final removal action completion reports (Tetra Tech EC Inc., 2007a and 2007b).

ft bgs = feet below ground surface
mg/kg = milligrams per kilogram
PSC = protective soil concentration
UCSF = University of California, San Francisco

ERRG ENGINEERING/REMEDIATION RESOURCES GROUP, INC.

Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 7-5
LOCATIONS WITH CHEMICAL CONCENTRATIONS EXCEEDING THE PROTECTIVE SOIL CONCENTRATION IN 0 - 3' SOIL
Remedial Investigation/Feasibility Study for Parcel E-2

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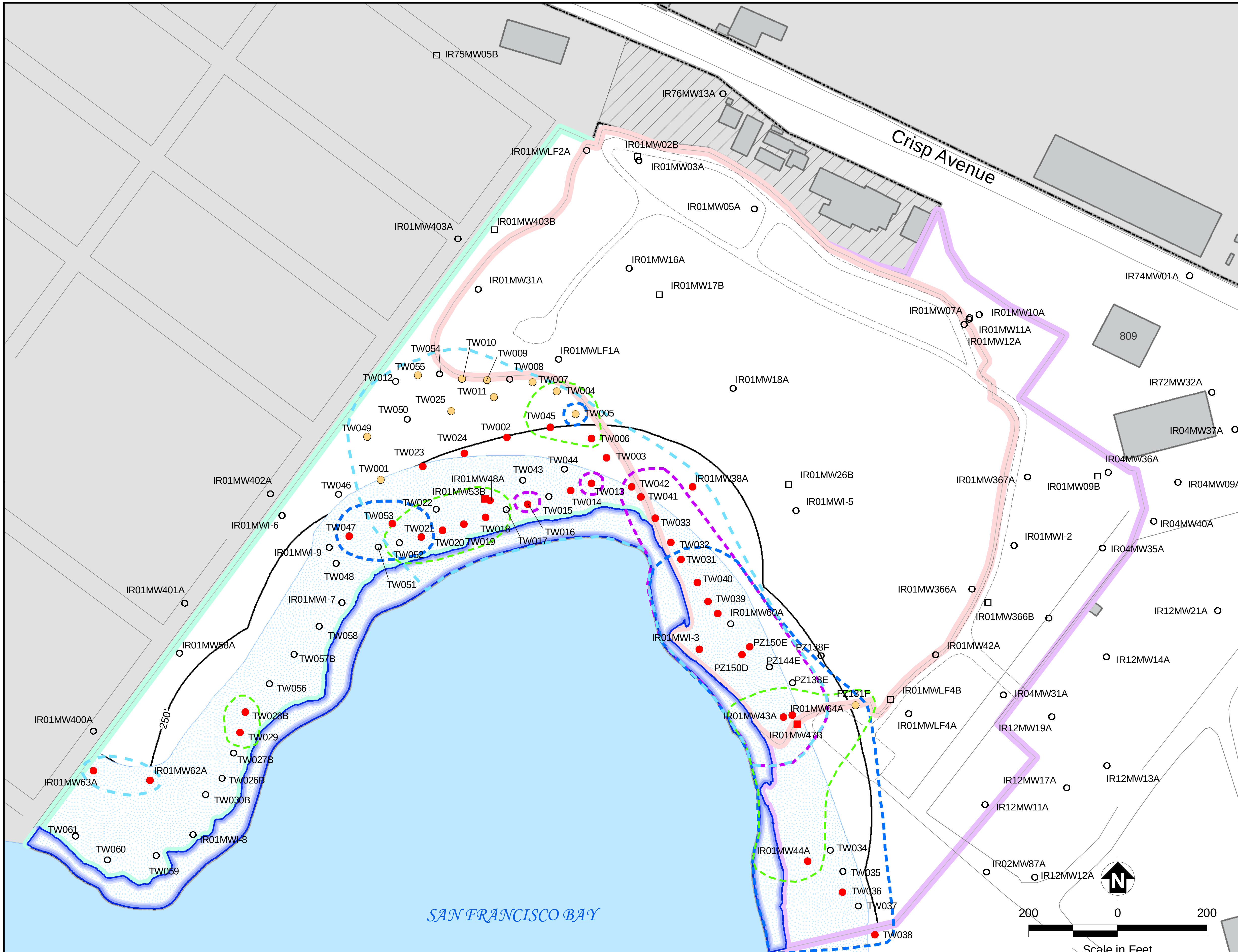

- A - aquifer nearshore well recommended for further monitoring and evaluation
- B - aquifer nearshore well recommended for further monitoring and evaluation
- A - aquifer inland well recommended for further monitoring and evaluation
- A-aquifer Well
- B-aquifer Well
- Shoreline Area
- Landfill Area
- Panhandle Area
- East Adjacent Area
- Tidal Influence Zone
- Road
- Gravel Road
- Parcel Boundary
- Building
- UCSF Compound
- San Francisco Bay
- Non-Navy Property
- 250' Distance from Shoreline (in feet)

Estimated areas where COPECs may be migrating to the bay at concentrations exceeding aquatic evaluation criteria:

- Anions
- Metals
- Total PCBs
- Total TPH

Notes:

The tidal influence study was conducted May 20 to June 3, 2002. (Tetra Tech EM Inc. 2004a.)

COPECs = chemicals of potential ecological concern
PCBs = polychlorinated biphenyls
TPH = total petroleum hydrocarbons
UCSF = University of California, San Francisco

Reference

Tetra Tech EM Inc. 2004a. "Revised Final Parcel E Groundwater Summary Report, Phase III Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California." October 17.

ERRG ENGINEERING/REMEDIATION RESOURCES GROUP, INC.

Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 7-6

SCREENING- AND TRIGGER-LEVEL GROUNDWATER EVALUATION FOR AQUATIC LIFE

Remedial Investigation/Feasibility Study for Parcel E-2

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Tables

Table 7-1. Human Health Risk Assessment Potentially Complete Pathways

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Exposure Scenario	Grid Size	SOIL						GROUNDWATER						
		0 – 2 feet bgs			0 – 10 feet bgs			A-Aquifer				B-Aquifer		
		Ingestion	Dermal	Inhalation (particulates and VOCs)	Ingestion	Dermal	Inhalation (particulates and VOCs)	Ingestion	Dermal	Inhalation (house-hold use)	Inhalation (construction trench)	Ingestion	Dermal	Inhalation (house-hold use)
Recreational	0.5 acre	●	●	●	--	--	--	--	--	--	--	--	--	--
Construction	0.5 acre	--	--	--	●	●	●	--	●	--	●	--	--	--
Groundwater Domestic Use	Not applicable	--	--	--	--	--	--	--	--	--	--	● [a]	● [b]	● [a]

Notes:

a The groundwater domestic use pathways are incomplete for the A-aquifer. However, potential vertical hydraulic communication exists in some areas at Parcel E-2 between the A- and B-aquifers. Accordingly, the domestic use evaluation for the B-aquifer includes A-aquifer data.

b Addressed in Uncertainty Analysis (see Section K9 of Appendix K)

-- Not quantitatively evaluated in HHRA

● Quantitatively evaluated in HHRA

bgs Below ground surface

HHRA Human health risk assessment

VOC Volatile organic compound

Table 7-2. Total Risk -- Summary of Cancer Risks and Hazard Indices for Recreational Exposure Scenario[a], Surface Soil (0 to 2 feet bgs)

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AA32	**1E-05**	<1	<1
AA34	**1E-05**	<1	<1
AA35	7E-10	<1	<1
AA38	**1E-05**	<1	<1
AA39	**6E-04**	5E+00	**2E+00**
AA40	**6E-06**	<1	<1
AA41	**7E-06**	<1	<1
AB29	**1E-05**	<1	<1
AB30	**6E-06**	<1	<1
AB32	**1E-05**	<1	<1
AB35	**6E-06**	<1	<1
AB36	**4E-05**	6E+00	**6E+00**
AB37	2E-07	<1	<1
AB38	**8E-06**	<1	<1
AB39	**1E-05**	<1	<1
AB41	**1E-05**	<1	<1
AC29	**2E-05**	<1	<1
AC30	**4E-05**	<1	<1
AC32	**2E-05**	<1	<1
AC33	**4E-05**	<1	<1
AC34	**5E-05**	<1	<1
AC35	**2E-05**	<1	<1
AC39	**6E-05**	2E+00	<1
AC40	**5E-05**	2E+00	**2E+00**
AC41	**5E-05**	2E+00	<1
AC42	**2E-05**	<1	<1
AD29	**2E-05**	<1	<1
AD30	3E-09	<1	<1
AD32	**2E-05**	<1	<1
AD33	**2E-04**	4E+00	**3E+00**
AD34	**6E-05**	4E+00	**4E+00**
AD35	**2E-05**	<1	<1
AD41	**3E-05**	<1	<1
AE31	**1E-05**	<1	<1
AE33	**9E-06**	<1	<1
AF27	4E-09	<1	<1
AF32	**2E-05**	<1	<1
AG27	**2E-05**	<1	<1
AG28	**2E-05**	<1	<1
AG31	**1E-05**	<1	<1
AG32	**2E-05**	<1	<1

Table 7-2. Total Risk -- Summary of Cancer Risks and Hazard Indices for Recreational Exposure Scenario[a], Surface Soil (0 to 2 feet bgs) *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AG34	**5E-05**	2E+00	<1
AH28	**9E-06**	<1	<1
AH29	**2E-05**	<1	<1
AH32	**9E-06**	<1	<1
AH33	**7E-06**	<1	<1
AH34	**9E-05**	2E+01	**2E+01**
AI28	**1E-05**	<1	<1
AI34	**3E-05**	2E+00	<1
AI35	**1E-04**	2E+01	**1E+01**
AJ28	**9E-06**	<1	<1
AJ29	**1E-05**	<1	<1
AJ30	**5E-05**	<1	<1
AJ31	**3E-05**	<1	<1
AJ34	**3E-05**	4E+00	**4E+00**
AJ35	**7E-04**	1E+02	**1E+02**
AJ36	**2E-04**	3E+01	**3E+01**
AK29	**5E-05**	5E+00	**2E+00**
AK30	**5E-05**	5E+00	**4E+00**
AK31	**5E-05**	7E+00	**6E+00**
AK32	**7E-05**	1E+01	**9E+00**
AK34	**6E-05**	5E+00	**4E+00**
AK36	**1E-05**	2E+00	<1
AK37	**3E-05**	2E+00	**2E+00**
AL33	**3E-05**	<1	<1
AL34	**3E-05**	<1	<1
AL36	**4E-06**	<1	<1

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1 for segregated noncancer hazards.

a Open space is the only reasonably anticipated reuse for Parcel E-2.

<1 Less than 1
bgs Below ground surface
HI Hazard index
RME Reasonable maximum exposure

Table 7-3. Incremental Risk -- Summary of Cancer Risks and Hazard Indices for Recreational Exposure Scenario[a], Surface Soil (0 to 2 feet bgs)

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AA32	9E-08	<1	<1
AA34	2E-09	<1	<1
AA35	**--**	<1	<1
AA38	**--**	<1	<1
AA39	**6E-04**	5E+00	**2E+00**
AA40	4E-08	<1	<1
AA41	**--**	<1	<1
AB29	**3E-06**	<1	<1
AB30	6E-08	<1	<1
AB32	3E-08	<1	<1
AB35	1E-08	<1	<1
AB36	**3E-05**	6E+00	**6E+00**
AB37	2E-07	<1	<1
AB38	**--**	<1	<1
AB39	4E-08	<1	<1
AB41	8E-11	<1	<1
AC29	**5E-06**	<1	<1
AC30	**3E-05**	<1	<1
AC32	**4E-06**	<1	<1
AC33	**3E-05**	<1	<1
AC34	**3E-05**	<1	<1
AC35	**2E-06**	<1	<1
AC39	**6E-05**	2E+00	<1
AC40	**5E-05**	2E+00	**2E+00**
AC41	**5E-05**	2E+00	<1
AC42	6E-07	<1	<1
AD29	**3E-06**	<1	<1
AD30	2E-09	<1	<1
AD32	**1E-05**	<1	<1
AD33	**2E-04**	4E+00	**3E+00**
AD34	**6E-05**	4E+00	**4E+00**
AD35	7E-07	<1	<1
AD41	1E-06	<1	<1
AE31	**6E-06**	<1	<1
AE33	3E-07	<1	<1
AF27	**--**	<1	<1
AF32	**9E-06**	<1	<1
AG27	7E-08	<1	<1
AG28	4E-07	<1	<1
AG31	6E-11	<1	<1
AG32	**1E-05**	<1	<1

Table 7-3. Incremental Risk -- Summary of Cancer Risks and Hazard Indices for Recreational Exposure Scenario[a], Surface Soil (0 to 2 feet bgs) *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AG34	**4E-05**	<1	<1
AH28	1E-07	<1	<1
AH29	**1E-05**	<1	<1
AH32	2E-09	<1	<1
AH33	**--**	<1	<1
AH34	**9E-05**	2E+01	**2E+01**
AI28	8E-09	<1	<1
AI34	**7E-06**	<1	<1
AI35	**9E-05**	2E+01	**1E+01**
AJ28	3E-07	<1	<1
AJ29	**2E-06**	<1	<1
AJ30	**3E-05**	<1	<1
AJ31	1E-07	<1	<1
AJ34	**2E-05**	4E+00	**4E+00**
AJ35	**6E-04**	1E+02	**1E+02**
AJ36	**2E-04**	3E+01	**3E+01**
AK29	**5E-05**	5E+00	**2E+00**
AK30	**2E-05**	4E+00	**4E+00**
AK31	**3E-05**	7E+00	**6E+00**
AK32	**5E-05**	9E+00	**9E+00**
AK34	**6E-05**	5E+00	**4E+00**
AK36	**1E-05**	2E+00	<1
AK37	**3E-05**	2E+00	**2E+00**
AL33	**1E-05**	<1	<1
AL34	**2E-05**	<1	<1
AL36	**4E-06**	<1	<1

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1 for segregated noncancer hazards.

a Open space is the only reasonably anticipated reuse for Parcel E-2.

<1 Less than 1
-- Not applicable
bgs Below ground surface
HI Hazard index
RME Reasonable maximum exposure

Table 7-4. Total Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario [a]
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		COC	Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Metals: HPAL	RME EPC Exceeds HPAL?
AA32	1E-05	<1	<1	Metal	Arsenic	C	4.1 - 4.6	4.60E+00	2/2	1.24E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AA34	1E-05	<1	<1	Metal	Arsenic	C	4.3 - 4.3	4.30E+00	1/1	1.16E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AA38	1E-05	<1	<1	Metal	Arsenic	C	4.6 - 4.6	4.60E+00	1/1	1.24E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	186 - 186	1.86E+02	1/1	--	--	--	--	--	--	--	--	8.99	Yes
AA39	6E-04	5E+00	2E+00	Metal	Antimony	NC	85 - 530	5.30E+02	2/5	--	--	--	--	1.94E+00	100.0%	0.0%	0.0%	9.05	Yes
					Arsenic	C,NC	3.3 - 215	2.15E+02	3/5	5.79E-04	62.8%	37.2%	0.0%	1.60E+00	65.5%	34.4%	0.1%	11.1	Yes
					Lead	--	36 - 4900	4.90E+03	4/5	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.31 - 0.31	3.10E-01	1/5	2.37E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AA40	6E-06	<1	<1	Metal	Arsenic	C	2.1 - 2.1	2.10E+00	1/1	5.65E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AA41	7E-06	<1	<1	Metal	Arsenic	C	2.5 - 2.5	2.50E+00	1/1	6.73E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AB29	1E-05	<1	<1	Metal	Arsenic	C	2 - 2.9	2.90E+00	2/2	7.81E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	0.26 - 0.26	2.60E-01	1/2	1.99E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AB30	6E-06	<1	<1	Metal	Arsenic	C	1.5 - 2.1	2.10E+00	2/2	5.65E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AB32	1E-05	<1	<1	Metal	Arsenic	C	3.9 - 3.9	3.90E+00	1/1	1.05E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AB35	6E-06	<1	<1	Metal	Arsenic	C	1.9 - 2.1	2.10E+00	2/2	5.65E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AB36	4E-05	6E+00	6E+00	Metal	Arsenic	C	1.8 - 3	3.00E+00	3/6	8.08E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	54 - 6270	6.27E+03	6/6	--	--	--	--	--	--	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.023 - 20	2.00E+01	2/4	2.69E-05	26.6%	73.4%	0.0%	5.04E+00	29.0%	71.0%	0.0%	--	--
					Total PCBs (Non-Dioxin)	C	4.09 - 4.14	4.14E+00	2/2	5.58E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AB38	8E-06	<1	<1	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/1	8.34E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AB39	1E-05	<1	<1	Metal	Arsenic	C	3.4 - 5.1	5.10E+00	3/3	1.37E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	39.7 - 222	2.22E+02	3/3	--	--	--	--	--	--	--	--	8.99	Yes
AB41	1E-05	<1	<1	Metal	Arsenic	C	4.8 - 4.8	4.80E+00	1/1	1.29E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AC29	2E-05	<1	<1	Metal	Arsenic	C	4.4 - 4.4	4.40E+00	1/1	1.18E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	0.51 - 0.51	5.10E-01	1/1	3.90E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AC30	4E-05	<1	<1	Metal	Arsenic	C	5.3 - 5.3	5.30E+00	1/1	1.43E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	2.4 - 2.4	2.40E+00	1/1	1.84E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	3.1 - 3.1	3.10E+00	1/1	2.37E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Indeno(1,2,3-cd)pyrene	C	2.9 - 2.9	2.90E+00	1/1	2.22E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AC32	2E-05	<1	<1	Metal	Arsenic	C	7.6 - 7.6	7.60E+00	1/1	2.05E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	0.43 - 0.43	4.30E-01	1/1	3.29E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AC33	4E-05	<1	<1	Metal	Arsenic	C	3.2 - 6	6.00E+00	4/4	1.62E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)anthracene	C	0.16 - 6.1	6.10E+00	3/4	4.67E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(a)pyrene	C	0.25 - 1.9	1.90E+00	3/4	1.45E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	0.35 - 4.9	4.90E+00	3/4	3.75E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(k)fluoranthene	C	0.16 - 4	4.00E+00	3/4	3.06E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AC34	5E-05	<1	<1	Metal	Arsenic	C	4.7 - 8.2	8.20E+00	3/3	2.21E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	110 - 302	3.02E+02	3/3	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.09 - 3.1	3.10E+00	3/3	2.37E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	0.16 - 3.7	3.70E+00	3/3	2.83E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(k)fluoranthene	C	0.52 - 4.3	4.30E+00	2/3	3.29E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AC35	2E-05	<1	<1	Metal	Arsenic	C	7.5 - 7.5	7.50E+00	1/1	2.02E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AC39	6E-05	2E+00	<1	Metal	Arsenic	C	14 - 23	2.30E+01	2/2	6.19E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	1000 - 2000	2.00E+03	2/2	--	--	--	--	--	--	--	--	8.99	Yes

Table 7-4. Total Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario [a] *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

											Percent Contribution by Exposure Pathway to Total RME Cancer Risk				Percent Contribution by Exposure Pathway to Total RME HI			Metals	
Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		COC	Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	HPAL	RME EPC Exceeds HPAL?
AC40	5E-05	2E+00	2E+00	Metal	Arsenic	C	6.09 - 16	1.51E+01	4/4	4.05E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	211 - 8600	7.42E+03	4/4	--	--	--	--	--	--	--	--	8.99	Yes
				Pest/PCB	Aroclor-1254	C	0.021 - 1.85	1.85E+00	2/4	2.49E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AC41	5E-05	2E+00	<1	Metal	Arsenic	C	6.3 - 18	1.73E+01	4/4	4.65E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	1000 - 1800	1.80E+03	4/4	--	--	--	--	--	--	--	--	8.99	Yes
AC42	2E-05	<1	<1	Metal	Arsenic	C	4.3 - 6.3	5.80E+00	5/5	1.56E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	100 - 310	2.57E+02	5/5	--	--	--	--	--	--	--	--	8.99	Yes
AD29	2E-05	<1	<1	Metal	Arsenic	C	4.8 - 4.8	4.80E+00	1/1	1.29E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	0.3 - 0.3	3.00E-01	1/1	2.30E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AD32	2E-05	<1	<1	Metal	Arsenic	C	4.8 - 4.8	4.80E+00	1/1	1.29E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/1	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AD33	2E-04	4E+00	3E+00	Metal	Arsenic	C	4.8 - 11	1.04E+01	4/4	2.81E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	64 - 730	6.84E+02	4/4	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)anthracene	C	0.27 - 5.3	5.30E+00	3/4	4.06E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(a)pyrene	C	0.23 - 8.6	8.04E+00	4/4	6.15E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	0.25 - 12	1.11E+01	4/4	8.48E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(k)fluoranthene	C	0.27 - 4.5	4.50E+00	4/4	3.44E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Indeno(1,2,3-cd)pyrene	C	0.22 - 8.3	8.03E+00	4/4	6.14E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1248	C,NC	0.12 - 12	1.20E+01	2/4	1.62E-05	26.6%	73.4%	0.0%	3.02E+00	29.0%	71.0%	0.0%	--	--
					Dieldrin	C	6.4 - 6.4	6.40E+00	1/4	5.45E-05	33.6%	66.4%	0.0%	<1	--	--	--	--	--
AD34	6E-05	4E+00	4E+00	Metal	Arsenic	C	2.8 - 13	1.30E+01	3/3	3.50E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	20 - 530	5.30E+02	3/3	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.1 - 0.54	5.40E-01	3/3	4.13E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.098 - 14	1.40E+01	2/3	1.88E-05	26.6%	73.4%	0.0%	3.53E+00	29.0%	71.0%	0.0%	--	--
AD35	2E-05	<1	<1	Metal	Arsenic	C	6.5 - 6.6	6.60E+00	2/2	1.78E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AD41	3E-05	<1	<1	Metal	Arsenic	C	9.1 - 9.1	9.10E+00	1/1	2.45E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	370 - 370	3.70E+02	1/1	--	--	--	--	--	--	--	--	8.99	Yes
AE31	1E-05	<1	<1	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/1	8.34E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	0.56 - 0.56	5.60E-01	1/1	4.29E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AE33	9E-06	<1	<1	Metal	Arsenic	C	3.2 - 3.2	3.20E+00	1/1	8.61E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AF32	2E-05	<1	<1	Metal	Arsenic	C	5.2 - 5.2	5.20E+00	1/1	1.40E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	0.86 - 0.86	8.60E-01	1/1	6.58E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AG27	2E-05	<1	<1	Metal	Arsenic	C	3.9 - 6.1	6.10E+00	2/2	1.64E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AG28	2E-05	<1	<1	Metal	Arsenic	C	1.3 - 5.6	5.60E+00	3/4	1.51E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AG31	1E-05	<1	<1	Metal	Arsenic	C	5.2 - 5.2	5.20E+00	1/1	1.40E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AG32	2E-05	<1	<1	Metal	Arsenic	C	4 - 4	4.00E+00	1/1	1.08E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/1	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AG34	5E-05	2E+00	<1	Metal	Arsenic	C	3.9 - 4.5	4.50E+00	2/2	1.21E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)anthracene	C	2.3 - 2.3	2.30E+00	1/2	1.76E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(a)pyrene	C	3.1 - 3.1	3.10E+00	1/2	2.37E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	4.1 - 4.1	4.10E+00	1/2	3.14E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Indeno(1,2,3-cd)pyrene	C	3.1 - 3.1	3.10E+00	1/2	2.37E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C	0.23 - 4.4	4.40E+00	4/5	5.92E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AH28	9E-06	<1	<1	Metal	Arsenic	C	1.5 - 3.4	3.40E+00	3/3	9.15E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No

Table 7-4. Total Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario [a] *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	COC		Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Metals: HPAL	RME EPC Exceeds HPAL?
AH29	2E-05	<1	<1	Metal	Arsenic	C	4.5 - 4.5	4.50E+00	1/1	1.21E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/1	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AH32	9E-06	<1	<1	Metal	Arsenic	C	3.2 - 3.2	3.20E+00	1/1	8.61E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AH33	7E-06	<1	<1	Metal	Arsenic	C	2.5 - 2.5	2.50E+00	1/1	6.73E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AH34	9E-05	2E+01	2E+01	Pest/PCB	Aroclor-1242	C	2.9 - 2.9	2.90E+00	1/5	3.90E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
					Aroclor-1254	C	1.8 - 1.8	1.80E+00	1/5	2.42E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
					Aroclor-1260	C,NC	1.8 - 94	5.99E+01	5/5	8.07E-05	26.6%	73.4%	0.0%	1.51E+01	29.0%	71.0%	0.0%	--	--
AI28	1E-05	<1	<1	Metal	Arsenic	C	1.8 - 4.5	4.50E+00	2/2	1.21E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AI34	3E-05	2E+00	<1	Metal	Arsenic	C	3.1 - 7.3	6.56E+00	4/5	1.77E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	10 - 210	1.67E+02	5/5	--	--	--	--	--	--	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C	0.23 - 5.3	5.30E+00	6/6	7.14E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AI35	1E-04	2E+01	1E+01	Metal	Arsenic	C	5.5 - 6.7	6.70E+00	2/2	1.80E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	370 - 9700	9.70E+03	2/2	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.77 - 0.77	7.70E-01	1/2	5.89E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	48 - 59	5.90E+01	2/2	7.94E-05	26.6%	73.4%	0.0%	1.49E+01	29.0%	71.0%	0.0%	--	--
					Heptachlor epoxide	C	0.39 - 0.55	5.50E-01	2/2	2.66E-06	33.6%	66.4%	0.0%	<1	--	--	--	--	--
AJ28	9E-06	<1	<1	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/1	8.34E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AJ29	1E-05	<1	<1	Metal	Arsenic	C	3.5 - 3.5	3.50E+00	1/1	9.42E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AJ30	5E-05	<1	<1	Metal	Arsenic	C	6.4 - 6.4	6.40E+00	1/1	1.72E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	5760 - 5760	5.76E+03	1/1	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)anthracene	C	2.3 - 2.3	2.30E+00	1/1	1.76E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(a)pyrene	C	3.4 - 3.4	3.40E+00	1/1	2.60E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	6.6 - 6.6	6.60E+00	1/1	5.05E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(k)fluoranthene	C	2.1 - 2.1	2.10E+00	1/1	1.61E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
AJ31	3E-05	<1	<1	Metal	Arsenic	C	10.9 - 10.9	1.09E+01	1/1	2.93E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
AJ34	3E-05	4E+00	4E+00	Metal	Arsenic	C	1.85 - 2.8	2.80E+00	3/3	7.54E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
				Pest/PCB	Aroclor-1260	C,NC	1.12 - 14	1.40E+01	3/3	1.88E-05	26.6%	73.4%	0.0%	3.53E+00	29.0%	71.0%	0.0%	--	--
AJ35	7E-04	1E+02	1E+02	Metal	Arsenic	C	2.9 - 5.1	5.10E+00	2/2	1.37E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	470 - 770	7.70E+02	2/2	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)anthracene	C	3.3 - 3.3	3.30E+00	1/2	2.53E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(a)pyrene	C	2.2 - 2.2	2.20E+00	1/2	1.68E-05	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	2 - 2	2.00E+00	1/2	1.53E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(k)fluoranthene	C	3.5 - 3.5	3.50E+00	1/2	2.68E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	120 - 450	4.50E+02	2/2	6.06E-04	26.6%	73.4%	0.0%	1.13E+02	29.0%	71.0%	0.0%	--	--
					Heptachlor epoxide	C	0.93 - 3.2	3.20E+00	2/2	1.55E-05	33.6%	66.4%	0.0%	<1	--	--	--	--	--
AJ36	2E-04	3E+01	3E+01	Metal	Arsenic	C	6.4 - 17	1.70E+01	2/2	4.58E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	230 - 610	6.10E+02	2/2	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.33 - 0.53	5.30E-01	2/2	4.06E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	1.9 - 120	1.20E+02	2/2	1.62E-04	26.6%	73.4%	0.0%	3.02E+01	29.0%	71.0%	0.0%	--	--
					Heptachlor epoxide	C	0.0032 - 0.83	8.30E-01	2/2	4.02E-06	33.6%	66.4%	0.0%	<1	--	--	--	--	--
AK29	5E-05	5E+00	2E+00	Metal	Arsenic	C	6.5 - 12.6	1.26E+01	4/4	3.39E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	74.3 - 6920	6.92E+03	4/4	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.2 - 0.2	2.00E-01	1/4	1.53E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.21 - 8.9	8.90E+00	3/4	1.20E-05	26.6%	73.4%	0.0%	2.24E+00	29.0%	71.0%	0.0%	--	--

Table 7-4. Total Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario [a] *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	COC		Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Metals: HPAL	RME EPC Exceeds HPAL?
AK30	5E-05	5E+00	4E+00	Metal	Arsenic	C	4.3 - 9.9	9.90E+00	3/3	2.66E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	3170 - 11200	1.12E+04	3/3	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.24 - 0.24	2.40E-01	1/3	1.84E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	2.6 - 14	1.40E+01	3/3	1.88E-05	26.6%	73.4%	0.0%	3.53E+00	29.0%	71.0%	0.0%	--	--
AK31	5E-05	7E+00	6E+00	Metal	Arsenic	C	3.7 - 7	7.00E+00	3/4	1.88E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	307 - 9000	8.56E+03	4/4	--	--	--	--	--	--	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.15 - 25	2.50E+01	4/4	3.37E-05	26.6%	73.4%	0.0%	6.30E+00	29.0%	71.0%	0.0%	--	--
AK32	7E-05	1E+01	9E+00	Metal	Arsenic	C	4.2 - 5.6	5.60E+00	2/2	1.51E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	503 - 1500	1.50E+03	2/2	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.091 - 0.23	2.30E-01	2/2	1.76E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	26 - 37	3.70E+01	2/2	4.98E-05	26.6%	73.4%	0.0%	9.33E+00	29.0%	71.0%	0.0%	--	--
					Dieldrin	C	0.25 - 0.25	2.50E-01	1/2	2.13E-06	33.6%	66.4%	0.0%	<1	--	--	--	--	--
AK34	6E-05	5E+00	4E+00	Metal	Arsenic	C	1.88 - 12.7	1.27E+01	3/3	3.41E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	Yes
					Lead	--	24.5 - 182	1.82E+02	3/3	--	--	--	--	--	--	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	1.7 - 17.5	1.75E+01	3/3	2.36E-05	26.6%	73.4%	0.0%	4.41E+00	29.0%	71.0%	0.0%	--	--
AK36	1E-05	2E+00	<1	Metal	Lead	--	450 - 450	4.50E+02	1/1	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.58 - 0.58	5.80E-01	1/1	4.44E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C	2 - 3.9	3.90E+00	2/2	5.25E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AK37	3E-05	2E+00	2E+00	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/1	8.34E-06	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	500 - 500	5.00E+02	1/1	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	1.2 - 1.2	1.20E+00	1/1	9.19E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(k)fluoranthene	C	2 - 2	2.00E+00	1/1	1.53E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1248	C	3.8 - 3.8	3.80E+00	1/1	5.12E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
					Aroclor-1254	C	1.5 - 1.5	1.50E+00	1/1	2.02E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
					Aroclor-1260	C	3.6 - 3.6	3.60E+00	1/1	4.85E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AL33	3E-05	<1	<1	Metal	Arsenic	C	2.9 - 6.5	6.50E+00	3/3	1.75E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	59.6 - 227	2.27E+02	3/3	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.19 - 0.61	6.10E-01	2/3	4.67E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C	0.59 - 1.9	1.90E+00	2/3	2.56E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AL34	3E-05	<1	<1	Metal	Arsenic	C	2 - 6.3	6.30E+00	3/3	1.70E-05	62.8%	37.2%	0.0%	<1	--	--	--	11.1	No
					Lead	--	11.6 - 160	1.60E+02	3/3	--	--	--	--	--	--	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.31 - 1.1	1.10E+00	3/3	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
					Benzo(b)fluoranthene	C	0.67 - 2.7	2.70E+00	3/3	2.07E-06	28.0%	71.9%	0.0%	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C	1.3 - 1.4	1.40E+00	3/3	1.88E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--
AL36	4E-06	<1	<1	Pest/PCB	Aroclor-1260	C	2.6 - 2.6	2.60E+00	1/1	3.50E-06	26.6%	73.4%	0.0%	<1	--	--	--	--	--

Notes: All concentrations shown in mg/kg.

a Open space is the only reasonably anticipated reuse for Parcel E-2.

<1	Less than 1	DF	Detection frequency	NC	Noncancer effect
--	Not applicable or chemical is not a COC for this endpoint	EPC	Exposure point concentration	PAH	Polycyclic aromatic hydrocarbon
C	Cancer effect	HI	Hazard index	PCB	Polychlorinated biphenyl
COC	Chemical of concern	HPAL	Hunters Point ambient level	Pest	Pesticide
CR	Cancer risk	mg/kg	Milligram per kilogram	RME	Reasonable maximum exposure

Table 7-5. Incremental Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario[a]
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

											Percent Contribution by Exposure Pathway to Total RME Cancer Risk				Percent Contribution by Exposure Pathway to Total RME HI		
Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		COC	Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)
AA38	9E-08	<1	<1	Metal	Lead	--	186 - 186	1.86E+02	1/1	--	--	--	--	--	--	--	--
AA39	6E-04	5E+00	2E+00	Metal	Antimony	NC	85 - 530	5.30E+02	2/5	--	--	--	--	1.94E+00	100.0%	0.0%	0.0%
					Arsenic	C,NC	3.3 - 215	2.15E+02	3/5	5.79E-04	62.8%	37.2%	0.0%	1.60E+00	65.5%	34.4%	0.1%
					Lead	--	36 - 4900	4.90E+03	4/5	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.31 - 0.31	3.10E-01	1/5	2.37E-06	28.0%	71.9%	0.0%	--	--	--	--
AB29	3E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.26 - 0.26	2.60E-01	1/2	1.99E-06	28.0%	71.9%	0.0%	--	--	--	--
AB36	3E-05	6E+00	6E+00	Metal	Lead	--	54 - 6270	6.27E+03	6/6	--	--	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.023 - 20	2.00E+01	2/4	2.69E-05	26.6%	73.4%	0.0%	5.04E+00	29.0%	71.0%	0.0%
					Total PCBs (Non-Dioxin)	C	4.09 - 4.14	4.14E+00	2/2	5.58E-06	26.6%	73.4%	0.0%	<1	--	--	--
AB39	4E-08	<1	<1	Metal	Lead	--	39.7 - 222	2.22E+02	3/3	--	--	--	--	--	--	--	--
AC29	5E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.51 - 0.51	5.10E-01	1/1	3.90E-06	28.0%	71.9%	0.0%	--	--	--	--
AC30	3E-05	<1	<1	PAH	Benzo(a)pyrene	C	2.4 - 2.4	2.40E+00	1/1	1.84E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	3.1 - 3.1	3.10E+00	1/1	2.37E-06	28.0%	71.9%	0.0%	--	--	--	--
					Indeno(1,2,3-cd)pyrene	C	2.9 - 2.9	2.90E+00	1/1	2.22E-06	28.0%	71.9%	0.0%	--	--	--	--
AC32	4E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.43 - 0.43	4.30E-01	1/1	3.29E-06	28.0%	71.9%	0.0%	--	--	--	--
AC33	3E-05	<1	<1	PAH	Benzo(a)anthracene	C	0.16 - 6.1	6.10E+00	3/4	4.67E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(a)pyrene	C	0.25 - 1.9	1.90E+00	3/4	1.45E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	0.35 - 4.9	4.90E+00	3/4	3.75E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(k)fluoranthene	C	0.16 - 4	4.00E+00	3/4	3.06E-06	28.0%	71.9%	0.0%	--	--	--	--
AC34	3E-05	<1	<1	Metal	Lead	--	110 - 302	3.02E+02	3/3	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.09 - 3.1	3.10E+00	3/3	2.37E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	0.16 - 3.7	3.70E+00	3/3	2.83E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(k)fluoranthene	C	0.52 - 4.3	4.30E+00	2/3	3.29E-06	28.0%	71.9%	0.0%	--	--	--	--
AC35	2E-06	<1	<1		No COCs Identified												
AC39	6E-05	2E+00	<1	Metal	Arsenic	C	14 - 23	2.30E+01	2/2	6.19E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	1000 - 2000	2.00E+03	2/2	--	--	--	--	--	--	--	--
AC40	5E-05	2E+00	2E+00	Metal	Arsenic	C	6.09 - 16	1.51E+01	4/4	4.05E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	211 - 8600	7.42E+03	4/4	--	--	--	--	--	--	--	--
				Pest/PCB	Aroclor-1254	C	0.19 - 0.49	1.85E+00	2/4	2.49E-06	26.6%	73.4%	0.0%	<1	--	--	--
AC41	5E-05	2E+00	<1	Metal	Arsenic	C	6.3 - 18	1.73E+01	4/4	4.65E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	1000 - 1800	1.80E+03	4/4	--	--	--	--	--	--	--	--
AC42	6E-07	<1	<1	Metal	Lead	--	100 - 310	2.57E+02	5/5	--	--	--	--	--	--	--	--
AD29	3E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.3 - 0.3	3.00E-01	1/1	2.30E-06	28.0%	71.9%	0.0%	--	--	--	--
AD32	1E-05	<1	<1	PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/1	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--
AD33	2E-04	4E+00	3E+00	Metal	Lead	--	64 - 730	6.84E+02	4/4	--	--	--	--	--	--	--	--
				PAH	Benzo(a)anthracene	C	0.27 - 5.3	5.30E+00	3/4	4.06E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(a)pyrene	C	0.23 - 8.6	8.04E+00	4/4	6.15E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	0.25 - 12	1.11E+01	4/4	8.48E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(k)fluoranthene	C	0.27 - 4.5	4.50E+00	4/4	3.44E-06	28.0%	71.9%	0.0%	--	--	--	--
					Indeno(1,2,3-cd)pyrene	C	0.22 - 8.3	8.03E+00	4/4	6.14E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1248	C,NC	0.12 - 12	1.20E+01	2/4	1.62E-05	26.6%	73.4%	0.0%	3.02E+00	29.0%	71.0%	0.0%
					Dieldrin	C	6.4 - 6.4	6.40E+00	1/4	5.45E-05	33.6%	66.4%	0.0%	<1	--	--	--

Table 7-5. Incremental Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario[a] *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		COC	Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)
AD34	6E-05	4E+00	4E+00	Metal	Arsenic	C	2.8 - 13	1.30E+01	3/3	3.50E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	20 - 530	5.30E+02	3/3	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.1 - 0.54	5.40E-01	3/3	4.13E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.098 - 14	1.40E+01	2/3	1.88E-05	26.6%	73.4%	0.0%	3.53E+00	29.0%	71.0%	0.0%
AD41	1E-06	<1	<1	Metal	Lead	--	370 - 370	3.70E+02	1/1	--	--	--	--	--	--	--	--
AE31	6E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.56 - 0.56	5.60E-01	1/1	4.29E-06	28.0%	71.9%	0.0%	--	--	--	--
AF32	9E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.86 - 0.86	8.60E-01	1/1	6.58E-06	28.0%	71.9%	0.0%	--	--	--	--
AG32	1E-05	<1	<1	PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/1	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--
AG34	4E-05	<1	<1	PAH	Benzo(a)anthracene	C	2.3 - 2.3	2.30E+00	1/2	1.76E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(a)pyrene	C	3.1 - 3.1	3.10E+00	1/2	2.37E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	4.1 - 4.1	4.10E+00	1/2	3.14E-06	28.0%	71.9%	0.0%	--	--	--	--
					Indeno(1,2,3-cd)pyrene	C	3.1 - 3.1	3.10E+00	1/2	2.37E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C	0.23 - 4.4	4.40E+00	4/5	5.92E-06	26.6%	73.4%	0.0%	<1	--	--	--
AH29	1E-05	<1	<1	PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/1	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--
AH34	9E-05	2E+01	2E+01	Pest/PCB	Aroclor-1242	C	2.9 - 2.9	2.90E+00	1/5	3.90E-06	26.6%	73.4%	0.0%	<1	--	--	--
					Aroclor-1254	C	1.8 - 1.8	1.80E+00	1/5	2.42E-06	26.6%	73.4%	0.0%	<1	--	--	--
					Aroclor-1260	C,NC	1.8 - 94	5.99E+01	5/5	8.07E-05	26.6%	73.4%	0.0%	1.51E+01	29.0%	71.0%	0.0%
AI34	7E-06	<1	<1	Metal	Lead	--	10 - 210	1.67E+02	5/5	--	--	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C	0.23 - 5.3	5.30E+00	6/6	7.14E-06	26.6%	73.4%	0.0%	<1	--	--	--
AI35	9E-05	2E+01	1E+01	Metal	Lead	--	370 - 9700	9.70E+03	2/2	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.77 - 0.77	7.70E-01	1/2	5.89E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	48 - 59	5.90E+01	2/2	7.94E-05	26.6%	73.4%	0.0%	1.49E+01	29.0%	71.0%	0.0%
					Heptachlor epoxide	C	0.39 - 0.55	5.50E-01	2/2	2.66E-06	33.6%	66.4%	0.0%	<1	--	--	--
AJ29	2E-06	<1	<1		No COCs Identified												
AJ30	3E-05	<1	<1	Metal	Lead	--	5760 - 5760	5.76E+03	1/1	--	--	--	--	--	--	--	--
				PAH	Benzo(a)anthracene	C	2.3 - 2.3	2.30E+00	1/1	1.76E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(a)pyrene	C	3.4 - 3.4	3.40E+00	1/1	2.60E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	6.6 - 6.6	6.60E+00	1/1	5.05E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(k)fluoranthene	C	2.1 - 2.1	2.10E+00	1/1	1.61E-06	28.0%	71.9%	0.0%	--	--	--	--
AJ34	2E-05	4E+00	4E+00	Pest/PCB	Aroclor-1260	C,NC	1.12 - 14	1.40E+01	3/3	1.88E-05	26.6%	73.4%	0.0%	3.53E+00	29.0%	71.0%	0.0%
AJ35	6E-04	1E+02	1E+02	Metal	Lead	--	470 - 770	7.70E+02	2/2	--	--	--	--	--	--	--	--
				PAH	Benzo(a)anthracene	C	3.3 - 3.3	3.30E+00	1/2	2.53E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(a)pyrene	C	2.2 - 2.2	2.20E+00	1/2	1.68E-05	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	2 - 2	2.00E+00	1/2	1.53E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(k)fluoranthene	C	3.5 - 3.5	3.50E+00	1/2	2.68E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	120 - 450	4.50E+02	2/2	6.06E-04	26.6%	73.4%	0.0%	1.13E+02	29.0%	71.0%	0.0%
					Heptachlor epoxide	C	0.93 - 3.2	3.20E+00	2/2	1.55E-05	33.6%	66.4%	0.0%	<1	--	--	--
AJ36	2E-04	3E+01	3E+01	Metal	Arsenic	C	6.4 - 17	1.70E+01	2/2	4.58E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	230 - 610	6.10E+02	2/2	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.33 - 0.53	5.30E-01	2/2	4.06E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	1.9 - 120	1.20E+02	2/2	1.62E-04	26.6%	73.4%	0.0%	3.02E+01	29.0%	71.0%	0.0%
					Heptachlor epoxide	C	0.0032 - 0.83	8.30E-01	2/2	4.02E-06	33.6%	66.4%	0.0%	<1	--	--	--

Table 7-5. Incremental Risk -- Risk Characterization Analysis for Surface Soil (0 to 2 feet bgs) for Recreational Exposure Scenario[a] *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

											Percent Contribution by Exposure Pathway to Total RME Cancer Risk				Percent Contribution by Exposure Pathway to Total RME HI		
Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	COC		Basis for COC	Range of Detected Concentrations	RME EPC	DF	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Chemical-specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)
AK29	5E-05	5E+00	2E+00	Metal	Arsenic	C	6.5 - 12.6	1.26E+01	4/4	3.39E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	74.3 - 6920	6.92E+03	4/4	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.2 - 0.2	2.00E-01	1/4	1.53E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.21 - 8.9	8.90E+00	3/4	1.20E-05	26.6%	73.4%	0.0%	2.24E+00	29.0%	71.0%	0.0%
AK30	2E-05	4E+00	4E+00	Metal	Lead	--	3170 - 11200	1.12E+04	3/3	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.24 - 0.24	2.40E-01	1/3	1.84E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	2.6 - 14	1.40E+01	3/3	1.88E-05	26.6%	73.4%	0.0%	3.53E+00	29.0%	71.0%	0.0%
AK31	3E-05	7E+00	6E+00	Metal	Lead	--	307 - 9000	8.56E+03	4/4	--	--	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.15 - 25	2.50E+01	4/4	3.37E-05	26.6%	73.4%	0.0%	6.30E+00	29.0%	71.0%	0.0%
AK32	5E-05	9E+00	9E+00	Metal	Lead	--	503 - 1500	1.50E+03	2/2	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.091 - 0.23	2.30E-01	2/2	1.76E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	26 - 37	3.70E+01	2/2	4.98E-05	26.6%	73.4%	0.0%	9.33E+00	29.0%	71.0%	0.0%
					Dieldrin	C	0.25 - 0.25	2.50E-01	1/2	2.13E-06	33.6%	66.4%	0.0%	<1	--	--	--
AK34	6E-05	5E+00	4E+00	Metal	Arsenic	C	1.88 - 12.7	1.27E+01	3/3	3.41E-05	62.8%	37.2%	0.0%	<1	--	--	--
					Lead	--	24.5 - 182	1.82E+02	3/3	--	--	--	--	--	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	1.7 - 17.5	1.75E+01	3/3	2.36E-05	26.6%	73.4%	0.0%	4.41E+00	29.0%	71.0%	0.0%
AK36	1E-05	2E+00	<1	Metal	Lead	--	450 - 450	4.50E+02	1/1	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.58 - 0.58	5.80E-01	1/1	4.44E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C	2 - 3.9	3.90E+00	2/2	5.25E-06	26.6%	73.4%	0.0%	<1	--	--	--
AK37	3E-05	2E+00	2E+00	Metal	Lead	--	500 - 500	5.00E+02	1/1	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	1.2 - 1.2	1.20E+00	1/1	9.19E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(k)fluoranthene	C	2 - 2	2.00E+00	1/1	1.53E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1248	C	3.8 - 3.8	3.80E+00	1/1	5.12E-06	26.6%	73.4%	0.0%	<1	--	--	--
					Aroclor-1254	C	1.5 - 1.5	1.50E+00	1/1	2.02E-06	26.6%	73.4%	0.0%	<1	--	--	--
					Aroclor-1260	C	3.6 - 3.6	3.60E+00	1/1	4.85E-06	26.6%	73.4%	0.0%	<1	--	--	--
AL33	1E-05	<1	<1	Metal	Lead	--	59.6 - 227	2.27E+02	3/3	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.19 - 0.61	6.10E-01	2/3	4.67E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C	0.59 - 1.9	1.90E+00	2/3	2.56E-06	26.6%	73.4%	0.0%	<1	--	--	--
AL34	2E-05	<1	<1	Metal	Lead	--	11.6 - 160	1.60E+02	3/3	--	--	--	--	--	--	--	--
				PAH	Benzo(a)pyrene	C	0.31 - 1.1	1.10E+00	3/3	8.42E-06	28.0%	71.9%	0.0%	--	--	--	--
					Benzo(b)fluoranthene	C	0.67 - 2.7	2.70E+00	3/3	2.07E-06	28.0%	71.9%	0.0%	--	--	--	--
				Pest/PCB	Aroclor-1260	C	1.3 - 1.4	1.40E+00	3/3	1.88E-06	26.6%	73.4%	0.0%	<1	--	--	--
AL36	4E-06	<1	<1	Pest/PCB	Aroclor-1260	C	2.6 - 2.6	2.60E+00	1/1	3.50E-06	26.6%	73.4%	0.0%	<1	--	--	--

Notes: All concentrations shown in mg/kg.

1 Open space is the only reasonably anticipated reuse for Parcel E-2.

<1	Less than 1
--	Not applicable or chemical is not a COC for this endpoint
C	Cancer effect
COC	Chemical of concern
CR	Cancer risk
DF	Detection frequency
EPC	Exposure point concentration
HI	Hazard index
HPAL	Hunters Point ambient level
HPS	Hunters Point Shipyard
mg/kg	Milligram per kilogram
NC	Noncancer effect
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
Pest	Pesticide
RME	Reasonable maximum exposure

Table 7-6. Total Risk -- Summary of Cancer Risks and Hazard Indices by Planned Reuse, Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AA30	**2E-06**	<1	<1
AA31	**2E-06**	<1	<1
AA32	**3E-06**	2E+00	<1
AA34	**3E-06**	<1	<1
AA35	**4E-06**	<1	<1
AA38	**3E-06**	<1	<1
AA39	**2E-04**	2E+01	**6E+00**
AA40	1E-06	<1	<1
AA41	**4E-06**	<1	<1
AB29	**5E-06**	7E+00	**3E+00**
AB30	**4E-06**	<1	<1
AB31	**4E-06**	2E+00	<1
AB32	**4E-06**	2E+00	<1
AB33	**2E-05**	<1	<1
AB35	1E-06	<1	<1
AB36	**8E-06**	1E+01	**1E+01**
AB37	4E-08	<1	<1
AB38	**2E-06**	<1	<1
AB39	**2E-05**	5E+00	**2E+00**
AB41	**3E-06**	<1	<1
AC28	5E-07	<1	<1
AC29	**1E-05**	3E+01	**2E+01**
AC30	**2E-05**	1E+02	**1E+02**
AC32	**5E-06**	<1	<1
AC33	**9E-06**	<1	<1
AC34	**1E-05**	5E+00	**3E+00**
AC35	**5E-06**	<1	<1
AC39	**2E-05**	5E+00	**2E+00**
AC40	**1E-05**	4E+00	**2E+00**
AC41	**9E-06**	4E+00	**2E+00**
AC42	**4E-06**	<1	<1
AD28	**4E-06**	<1	<1
AD29	**1E-04**	2E+02	**2E+02**
AD30	**5E-06**	<1	<1
AD32	**7E-06**	5E+00	**2E+00**
AD33	**9E-05**	2E+01	**1E+01**
AD34	**1E-05**	1E+01	**7E+00**
AD35	**4E-06**	<1	<1
AD41	**6E-06**	<1	<1
AE28	**4E-06**	2E+00	<1

Table 7-6. Total Risk -- Summary of Cancer Risks and Hazard Indices by Planned Reuse, Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AE29	**5E-06**	2E+00	<1
AE31	**3E-05**	4E+01	**2E+01**
AE33	**4E-06**	<1	<1
AF27	**3E-06**	<1	<1
AF28	**5E-06**	5E+00	**3E+00**
AF29	**4E-06**	2E+00	<1
AF32	**5E-06**	<1	<1
AF33	**8E-06**	<1	<1
AG27	**6E-06**	<1	<1
AG28	**2E-06**	<1	<1
AG29	**3E-06**	<1	<1
AG31	**7E-06**	2E+00	<1
AG32	**1E-05**	2E+00	<1
AG34	**1E-04**	2E+02	**2E+02**
AH28	**3E-06**	<1	<1
AH29	**7E-06**	2E+00	<1
AH32	**1E-04**	1E+02	**7E+01**
AH33	**2E-05**	5E+00	**2E+00**
AH34	**2E-05**	3E+01	**2E+01**
AI28	**3E-05**	<1	<1
AI34	**2E-05**	3E+01	**3E+01**
AI35	**4E-04**	7E+02	**7E+02**
AJ28	**7E-05**	4E+00	**2E+00**
AJ29	**1E-05**	3E+00	<1
AJ30	**1E-05**	3E+00	<1
AJ31	**1E-05**	8E+00	**6E+00**
AJ33	**8E-06**	2E+00	<1
AJ34	**5E-05**	7E+01	**7E+01**
AJ35	**6E-04**	9E+02	**8E+02**
AJ36	**2E-04**	4E+02	**4E+02**
AK29	**9E-06**	9E+00	**3E+00**
AK30	**1E-05**	9E+00	**7E+00**
AK31	**7E-06**	1E+01	**7E+00**
AK32	**5E-05**	7E+01	**7E+01**
AK34	**7E-05**	1E+02	**1E+02**
AK35	**3E-06**	6E+00	**6E+00**
AK36	**2E-05**	2E+01	**1E+01**
AK37	**1E-05**	7E+00	**6E+00**
AL33	**6E-06**	3E+00	<1

Table 7-6. Total Risk -- Summary of Cancer Risks and Hazard Indices by Planned Reuse, Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AL34	**7E-06**	4E+00	**2E+00**
AL35	8E-07	<1	<1
AL36	**2E-05**	1E+01	**1E+01**

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1 for segregated noncancer hazards.

<1 Less than 1

-- Not applicable

bgs Below ground surface

HI Hazard index

RME Reasonable maximum exposure

Table 7-7. Incremental Risk -- Summary of Cancer Risks and Hazard Indices by Reuse, Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AA30	5E-08	<1	<1
AA31	6E-08	<1	<1
AA32	6E-07	<1	<1
AA34	2E-09	<1	<1
AA35	--	<1	<1
AA38	--	<1	<1
AA39	**2E-04**	2E+01	**6E+00**
AA40	7E-09	<1	<1
AA41	2E-08	<1	<1
AB29	**2E-06**	6E+00	**3E+00**
AB30	2E-07	<1	<1
AB31	5E-07	<1	<1
AB32	8E-07	<1	<1
AB33	**1E-05**	<1	<1
AB35	2E-09	<1	<1
AB36	**7E-06**	1E+01	**1E+01**
AB37	4E-08	<1	<1
AB38	6E-09	<1	<1
AB39	**2E-05**	5E+00	**2E+00**
AB41	2E-11	<1	<1
AC28	4E-08	<1	<1
AC29	**9E-06**	3E+01	**2E+01**
AC30	**1E-05**	1E+02	**1E+02**
AC32	8E-07	<1	<1
AC33	**6E-06**	<1	<1
AC34	**7E-06**	4E+00	**3E+00**
AC35	4E-07	<1	<1
AC39	**2E-05**	5E+00	**2E+00**
AC40	**1E-05**	4E+00	**2E+00**
AC41	**9E-06**	4E+00	**2E+00**
AC42	1E-07	<1	<1
AD28	3E-08	<1	<1
AD29	**1E-04**	2E+02	**2E+02**
AD30	2E-11	<1	<1
AD32	**3E-06**	4E+00	<1
AD33	**8E-05**	2E+01	**1E+01**
AD34	**1E-05**	1E+01	**7E+00**
AD35	1E-07	<1	<1
AD41	3E-07	<1	<1
AE28	2E-07	<1	<1

Table 7-7. Incremental Risk -- Summary of Cancer Risks and Hazard Indices by Reuse, Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AE29	2E-11	<1	<1
AE31	**3E-05**	4E+01	**2E+01**
AE33	3E-07	<1	<1
AF27	**--**	<1	<1
AF28	**2E-06**	4E+00	**3E+00**
AF29	3E-07	<1	<1
AF32	**2E-06**	<1	<1
AF33	**8E-06**	<1	<1
AG27	1E-08	<1	<1
AG28	9E-08	<1	<1
AG29	2E-08	<1	<1
AG31	**3E-06**	<1	<1
AG32	**1E-05**	<1	<1
AG34	**1E-04**	2E+02	**2E+02**
AH28	4E-07	<1	<1
AH29	**3E-06**	<1	<1
AH32	**1E-04**	1E+02	**7E+01**
AH33	**2E-05**	4E+00	**2E+00**
AH34	**2E-05**	3E+01	**2E+01**
AI28	**3E-05**	<1	<1
AI34	**2E-05**	3E+01	**3E+01**
AI35	**4E-04**	7E+02	**7E+02**
AJ28	**7E-05**	3E+00	**2E+00**
AJ29	**1E-05**	<1	<1
AJ30	**7E-06**	2E+00	<1
AJ31	**1E-05**	8E+00	**6E+00**
AJ33	**6E-06**	2E+00	<1
AJ34	**5E-05**	7E+01	**7E+01**
AJ35	**6E-04**	9E+02	**8E+02**
AJ36	**2E-04**	4E+02	**4E+02**
AK29	**9E-06**	8E+00	**3E+00**
AK30	**4E-06**	8E+00	**7E+00**
AK31	**7E-06**	1E+01	**7E+00**
AK32	**4E-05**	7E+01	**7E+01**
AK34	**7E-05**	1E+02	**1E+02**
AK35	**3E-06**	6E+00	**6E+00**
AK36	**2E-05**	1E+01	**1E+01**
AK37	**1E-05**	7E+00	**6E+00**
AL33	**2E-06**	2E+00	<1

Table 7-7. Incremental Risk -- Summary of Cancer Risks and Hazard Indices by Reuse, Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
AL34	**4E-06**	2E+00	**2E+00**
AL35	8E-07	<1	<1
AL36	**2E-05**	1E+01	**1E+01**

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1 for segregated noncancer hazards.

<1 Less than 1
-- Not applicable
bgs Below ground surface
HI Hazard index
RME Reasonable maximum exposure

Table 7-8. Risk Characterization Summary for A-Aquifer Groundwater, Construction Worker Scenario

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Exposure Area	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Exposure Pathway	Source Aquifer for Exposure Pathway	Total RME Cancer Risk for Exposure Pathway	Total RME HI for Exposure Pathway	RME Segregated HI for Exposure Pathway	Chemicals of Concern		Basis for Chemical of Concern	Detection Frequency	RME Concentration	Chemical-Specific Cancer Risk	Percent Contribution to Total RME Cancer Risk for Exposure Pathway	Chemical-Specific HI	Percent Contribution to Total RME HI for Exposure Pathway
Parcel E-2	1E-04	6E-01	<1	Trench Vapor Inhalation	A	6E-07	4E-01	<1		No Chemicals of Concern Identified	--	--	--	--	--	--	--
				Trench Dermal Contact	A	1E-04	2E-01	<1	PAH	Benzo(a)anthracene	C	7 / 277	4.0E+00	6.0E-06	4.01%	--	--
										Benzo(a)pyrene	C	4 / 275	3.5E+00	7.8E-05	52.46%	--	--
										Benzo(b)fluoranthene	C	4 / 275	6.0E+00	1.3E-05	8.99%	--	--
										Benzo(k)fluoranthene	C	1 / 275	1.1E+00	2.4E-06	1.65%	--	--
										Dibenz(a,h)anthracene	C	1 / 275	1.3E+00	3.8E-05	25.40%	--	--
										Indeno(1,2,3-cd)pyrene	C	3 / 275	3.0E+00	9.5E-06	6.42%	--	--

Notes: All concentrations shown in micrograms per liter.

--	Not applicable or chemical is not a chemical of concern for this endpoint
<1	Less than 1
A	A-aquifer
C	Cancer effect
HI	Hazard index
PAH	Polycyclic aromatic hydrocarbon
RME	Reasonable maximum exposure

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals	
												HPAL	Maximum Concentration Exceeds HPAL?
AA30	2E-06	<1	<1	Metal	Arsenic	C	3.8 - 3.8	3.80E+00	1/1	2.34E-06	<1	11.1	No
AA31	2E-06	<1	<1	Metal	Arsenic	C	3.6 - 3.7	3.70E+00	2/2	2.28E-06	<1	11.1	No
AA32	3E-06	2E+00	<1	Metal	Arsenic	C	3.9 - 4.6	4.39E+00	5/5	2.71E-06	<1	11.1	No
AA34	3E-06	<1	<1	Metal	Arsenic	C	2.5 - 4.3	4.30E+00	4/4	2.65E-06	<1	11.1	No
AA35	4E-06	<1	<1	Metal	Arsenic	C	3.4 - 6.6	6.60E+00	3/4	4.07E-06	<1	11.1	No
AA38	3E-06	<1	<1	Metal	Arsenic	C	3.1 - 4.6	4.60E+00	2/4	2.84E-06	<1	11.1	No
AA39	2E-04	2E+01	6E+00	Metal	Antimony	NC	10.4 - 530	5.30E+02	6/12	--	4E+00	9.05	Yes
					Arsenic	C,NC	3.3 - 315	3.15E+02	10/12	1.94E-04	5E+00	11.1	Yes
					Iron	NC	14000 - 217000	1.77E+05	12/12	--	2E+00	58000	Yes
					Lead	--	24.7 - 9300	9.30E+03	11/12	--	--	8.99	Yes
					Vanadium	NC	17 - 620	6.20E+02	12/12	--	2E+00	117.17	Yes
				PAH	Naphthalene	C	1.2 - 120	1.20E+02	6/12	1.59E-06	<1	--	--
AA41	4E-06	<1	<1	Metal	Arsenic	C	2.5 - 5.8	5.64E+00	4/4	3.48E-06	<1	11.1	No
AB29	5E-06	7E+00	3E+00	Metal	Antimony	NC	0.12 - 350	3.50E+02	5/10	--	3E+00	9.05	Yes
					Arsenic	C	1.6 - 7.6	4.65E+00	10/10	2.87E-06	<1	11.1	No
				Pest/PCB	Aroclor-1016	NC	13 - 13	1.30E+01	1/10	1.23E-07	2E+00	--	--
AB30	4E-06	<1	<1	Metal	Arsenic	C	1.5 - 6.5	6.36E+00	4/4	3.92E-06	<1	11.1	No
AB31	4E-06	2E+00	<1	Metal	Arsenic	C	3.9 - 5.9	5.90E+00	3/3	3.64E-06	<1	11.1	No
AB32	4E-06	2E+00	<1	Metal	Arsenic	C	3.7 - 5.9	5.35E+00	6/6	3.30E-06	<1	11.1	No
AB33	2E-05	<1	<1	Metal	Arsenic	C	1.2 - 4.9	4.90E+00	3/3	3.02E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	6.9 - 6.9	6.90E+00	1/3	1.07E-05	--	--	--
AB36	8E-06	1E+01	1E+01	Metal	Arsenic	C	0.2 - 3	2.98E+00	5/11	1.84E-06	<1	11.1	No
					Lead	--	3.4 - 6270	2.55E+03	11/11	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.023 - 20	2.00E+01	2/9	5.41E-06	9E+00	--	--
					Total PCBs (Non-Dioxin)	NC	4.09 - 4.14	4.14E+00	2/2	1.12E-06	2E+00	--	--
AB38	2E-06	<1	<1	Metal	Arsenic	C	2.5 - 3.9	3.90E+00	4/4	2.40E-06	<1	11.1	No
AB39	2E-05	5E+00	2E+00	Metal	Antimony	NC	2.1 - 300	3.00E+02	5/6	--	2E+00	9.05	Yes
					Arsenic	C	3.4 - 30	2.38E+01	6/6	1.47E-05	<1	11.1	Yes
					Lead	--	39.7 - 5400	3.29E+03	6/6	--	--	8.99	Yes
				Dioxin	Dioxin (TEQ)	C	0.00000004 - 0.000523	4.38E-04	4/4	4.29E-06	--	--	--

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals	
												HPAL	Maximum Concentration Exceeds HPAL?
AB41	3E-06	<1	<1	Metal	Arsenic	C	4.8 - 5.5	5.50E+00	2/2	3.39E-06	<1	11.1	No
AC29	1E-05	3E+01	2E+01	Metal	Arsenic	C	3.3 - 4.6	4.60E+00	3/3	2.84E-06	<1	11.1	No
				Pest/PCB	Aroclor-1016	NC	130 - 130	1.30E+02	1/3	1.23E-06	2E+01	--	--
					Aroclor-1260	C,NC	24 - 24	2.40E+01	1/3	6.50E-06	1E+01	--	--
AC30	2E-05	1E+02	1E+02	Metal	Arsenic	C	3.7 - 5.6	5.60E+00	4/4	3.45E-06	<1	11.1	No
					Lead	--	5.3 - 1020	1.02E+03	4/4	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.05 - 2.4	2.40E+00	2/4	3.71E-06	--	--	--
				Pest/PCB	Aroclor-1016	C,NC	740 - 740	7.40E+02	1/4	7.01E-06	1E+02	--	--
AC32	5E-06	<1	<1	Metal	Arsenic	C	3.1 - 7.6	7.60E+00	2/4	4.69E-06	<1	11.1	No
AC33	9E-06	<1	<1	Metal	Arsenic	C	3.2 - 6	5.32E+00	8/8	3.28E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	0.051 - 1.9	1.90E+00	5/8	2.94E-06	--	--	--
AC34	1E-05	5E+00	3E+00	Metal	Arsenic	C	3 - 10	8.13E+00	8/8	5.01E-06	<1	11.1	No
					Iron	NC	16000 - 471000	2.63E+05	8/8	--	3E+00	58000	Yes
				PAH	Benzo(a)pyrene	C	0.072 - 3.1	3.10E+00	6/8	4.80E-06	--	--	--
AC35	5E-06	<1	<1	Metal	Arsenic	C	6.6 - 7.5	7.50E+00	2/2	4.62E-06	<1	11.1	No
AC39	2E-05	5E+00	2E+00	Metal	Arsenic	C	14 - 23	2.11E+01	5/5	1.30E-05	<1	11.1	Yes
					Lead	--	420 - 2000	1.97E+03	5/5	--	--	8.99	Yes
					Manganese	NC	650 - 12000	1.20E+04	5/5	--	2E+00	1431.18	Yes
AC40	1E-05	4E+00	2E+00	Metal	Arsenic	C	6.09 - 25	1.74E+01	9/9	1.08E-05	<1	11.1	Yes
					Lead	--	211 - 8600	4.68E+03	9/9	--	--	8.99	Yes
AC41	9E-06	4E+00	2E+00	Metal	Arsenic	C	3.06 - 18	1.15E+01	8/8	7.12E-06	<1	11.1	Yes
					Copper	NC	50 - 27000	2.70E+04	8/8	--	2E+00	124.31	Yes
					Lead	--	87 - 1800	1.38E+03	8/8	--	--	8.99	Yes
AC42	4E-06	<1	<1	Metal	Arsenic	C	4.3 - 6.3	5.80E+00	5/5	3.57E-06	<1	11.1	No
AD28	4E-06	<1	<1	Metal	Arsenic	C	4 - 6.1	6.10E+00	2/2	3.76E-06	<1	11.1	No
AD29	1E-04	2E+02	2E+02	Metal	Arsenic	C	4.2 - 12.6	1.14E+01	4/4	7.02E-06	<1	11.1	Yes
				Pest/PCB	Aroclor-1254	C,NC	7.1 - 7.1	7.10E+00	1/2	1.92E-06	3E+00	--	--
					Aroclor-1260	C,NC	8.6 - 370	3.70E+02	2/2	1.00E-04	2E+02	--	--
AD30	5E-06	<1	<1	Metal	Arsenic	C	8.8 - 8.8	8.80E+00	1/2	5.43E-06	<1	11.1	No

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals: HPAL	Metals: Maximum Concentration Exceeds HPAL?
AD32	7E-06	5E+00	2E+00	Metal	Arsenic	C	3.9 - 6.2	6.06E+00	4/4	3.74E-06	<1	11.1	No
					Lead	--	58 - 3840	3.36E+03	4/4	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.052 - 1.1	1.10E+00	2/4	1.70E-06	--	--	--
AD33	9E-05	2E+01	1E+01	Metal	Arsenic	C	4.1 - 11	8.66E+00	7/8	5.34E-06	<1	11.1	No
				PAH	Benzo(a)anthracene	C	0.058 - 51	5.10E+01	6/8	7.89E-06	--	--	--
					Benzo(a)pyrene	C	0.059 - 16	1.60E+01	6/8	2.48E-05	--	--	--
					Benzo(b)fluoranthene	C	0.064 - 64	6.40E+01	7/8	9.91E-06	--	--	--
					Benzo(k)fluoranthene	C	0.058 - 53	5.30E+01	6/8	8.20E-06	--	--	--
					Dibenz(a,h)anthracene	C	5.3 - 5.3	5.30E+00	1/8	4.99E-06	--	--	--
					Indeno(1,2,3-cd)pyrene	C	0.053 - 17	1.70E+01	7/8	2.63E-06	--	--	--
				Pest/PCB	Aroclor-1248	C,NC	0.12 - 12	1.20E+01	2/8	3.25E-06	6E+00	--	--
					Aroclor-1254	C,NC	0.037 - 17	1.70E+01	2/8	4.60E-06	8E+00	--	--
					Dieldrin	C	3.2 - 6.4	6.40E+00	2/8	1.13E-05	<1	--	--
AD34	1E-05	1E+01	7E+00	Metal	Arsenic	C	2.8 - 13	1.06E+01	6/6	6.52E-06	<1	11.1	No
					Vanadium	NC	31 - 2100	1.08E+03	6/6	--	3E+00	117.17	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.072 - 14	1.40E+01	5/6	3.79E-06	7E+00	--	--
AD35	4E-06	<1	<1	Metal	Arsenic	C	3.8 - 6.6	6.60E+00	4/4	4.07E-06	<1	11.1	No
AD41	6E-06	<1	<1	Metal	Arsenic	C	9.1 - 9.1	9.10E+00	1/1	5.61E-06	<1	11.1	No
AE28	4E-06	2E+00	<1	Metal	Arsenic	C	3.2 - 6.7	5.77E+00	5/6	3.56E-06	<1	11.1	No
AE29	5E-06	2E+00	<1	Metal	Arsenic	C	6.4 - 8.7	8.70E+00	3/3	5.36E-06	<1	11.1	No
AE31	3E-05	4E+01	2E+01	Metal	Antimony	NC	42.5 - 1930	1.93E+03	2/2	--	2E+01	9.05	Yes
					Arsenic	C	3 - 47.8	4.78E+01	4/4	2.95E-05	<1	11.1	Yes
					Copper	NC	42 - 167000	1.67E+05	4/4	--	1E+01	124.31	Yes
				Pest/PCB	Aroclor-1242	C,NC	0.024 - 7.2	6.20E+00	4/4	1.68E-06	3E+00	--	--
AE33	4E-06	<1	<1	Metal	Arsenic	C	3.2 - 6.4	6.02E+00	6/6	3.71E-06	<1	11.1	No
AF27	3E-06	<1	<1	Metal	Arsenic	C	5.1 - 5.1	5.10E+00	1/2	3.14E-06	<1	11.1	No
AF28	5E-06	5E+00	3E+00	Metal	Arsenic	C	1.4 - 5.1	5.10E+00	2/2	3.14E-06	<1	11.1	No
				Pest/PCB	Aroclor-1260	C,NC	0.056 - 7.2	7.20E+00	2/2	1.95E-06	3E+00	--	--
AF29	4E-06	2E+00	<1	Metal	Arsenic	C	4.3 - 6.8	6.47E+00	4/4	3.99E-06	<1	11.1	No
AF32	5E-06	<1	<1	Metal	Arsenic	C	4.1 - 5.2	5.20E+00	2/2	3.21E-06	<1	11.1	No

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals HPAL	Metals Maximum Concentration Exceeds HPAL?
AF33	8E-06	<1	<1	Metal	Arsenic	C	11.3 - 12.2	1.22E+01	2/2	7.52E-06	<1	11.1	Yes
AG27	6E-06	<1	<1	Metal	Arsenic	C	3.9 - 9.3	9.30E+00	3/6	5.73E-06	<1	11.1	No
AG28	2E-06	<1	<1	Metal	Arsenic	C	1.3 - 5.6	3.90E+00	9/10	2.40E-06	<1	11.1	No
AG29	3E-06	<1	<1	Metal	Arsenic	C	2.1 - 5.6	5.60E+00	3/3	3.45E-06	<1	11.1	No
AG31	7E-06	2E+00	<1	Metal	Arsenic	C	2.7 - 5.5	5.50E+00	4/4	3.39E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	1.3 - 1.3	1.30E+00	1/4	2.01E-06	--	--	--
AG32	1E-05	2E+00	<1	Metal	Arsenic	C	4 - 17.4	1.57E+01	4/4	9.67E-06	<1	11.1	Yes
				PAH	Benzo(a)pyrene	C	0.18 - 1.1	1.10E+00	2/4	1.70E-06	--	--	--
AG34	1E-04	2E+02	2E+02	Metal	Arsenic	C	1 - 10	6.73E+00	15/15	4.15E-06	<1	11.1	No
					Lead	--	14 - 1800	1.80E+03	15/15	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.0088 - 3.1	1.29E+00	12/15	1.99E-06	--	--	--
				Pest/PCB	Aroclor-1242	C,NC	15 - 15	1.50E+01	1/15	4.06E-06	7E+00	--	--
					Aroclor-1260	C,NC	0.038 - 380	3.20E+02	13/15	8.67E-05	2E+02	--	--
AH28	3E-06	<1	<1	Metal	Arsenic	C	1.5 - 6.5	4.63E+00	6/7	2.86E-06	<1	11.1	No
AH29	7E-06	2E+00	<1	Metal	Arsenic	C	3.5 - 9.1	7.35E+00	5/5	4.53E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	1.1 - 1.1	1.10E+00	1/5	1.70E-06	--	--	--
AH32	1E-04	1E+02	7E+01	Metal	Antimony	NC	487 - 675	6.75E+02	2/2	--	5E+00	9.05	Yes
					Arsenic	C	3.2 - 66.6	5.75E+01	4/4	3.54E-05	<1	11.1	Yes
					Cadmium	NC	10.3 - 330	3.30E+02	2/4	1.05E-08	2E+00	3.14	Yes
					Copper	NC	55.5 - 175000	1.52E+05	4/4	--	1E+01	124.31	Yes
					Iron	NC	30200 - 165000	1.47E+05	4/4	--	2E+00	58000	Yes
					Lead	--	7.7 - 3720	3.64E+03	4/4	--	--	8.99	Yes
					Vanadium	NC	58.3 - 24900	2.09E+04	4/4	--	7E+01	117.17	Yes
				PAH	Benzo(a)anthracene	C	1.3 - 80	8.00E+01	2/4	1.24E-05	--	--	--
					Benzo(a)pyrene	C	0.13 - 16	1.60E+01	2/4	2.48E-05	--	--	--
					Benzo(b)fluoranthene	C	0.52 - 43	4.30E+01	2/4	6.66E-06	--	--	--
					Benzo(k)fluoranthene	C	0.11 - 13	1.30E+01	2/4	2.01E-06	--	--	--
					Naphthalene	C,NC	2.2 - 1400	1.40E+03	2/4	1.86E-05	8E+00	--	--

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals	
												HPAL	Maximum Concentration Exceeds HPAL?
AH33	2E-05	5E+00	2E+00	Metal	Arsenic	C	2.5 - 4.9	4.89E+00	4/4	3.01E-06	<1	11.1	No
				PAH	Benzo(a)anthracene	C	0.1 - 11	1.10E+01	3/4	1.70E-06	--	--	--
					Benzo(a)pyrene	C	0.1 - 7.5	7.50E+00	3/4	1.16E-05	--	--	--
					Benzo(b)fluoranthene	C	0.13 - 10	1.00E+01	3/4	1.55E-06	--	--	--
				Pest/PCB	Aroclor-1260	NC	1.6 - 3.4	3.40E+00	2/4	9.20E-07	2E+00	--	--
AH34	2E-05	3E+01	2E+01	Metal	Antimony	NC	0.34 - 400	4.00E+02	12/13	--	3E+00	9.05	Yes
					Arsenic	C	2 - 9.6	5.93E+00	12/13	3.66E-06	<1	11.1	No
					Lead	--	4.1 - 2200	1.04E+03	13/13	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	0.013 - 3	2.05E+00	12/13	3.17E-06	--	--	--
				Pest/PCB	Aroclor-1254	NC	0.29 - 5.1	5.10E+00	7/18	1.38E-06	2E+00	--	--
					Aroclor-1260	C,NC	0.03 - 94	3.93E+01	18/18	1.06E-05	2E+01	--	--
AI28	3E-05	<1	<1	Metal	Arsenic	C	1.8 - 5.5	5.50E+00	4/4	3.39E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	12 - 12	1.20E+01	1/3	1.86E-05	--	--	--
					Benzo(b)fluoranthene	C	17 - 17	1.70E+01	1/3	2.63E-06	--	--	--
					Dibenz(a,h)anthracene	C	2 - 2	2.00E+00	1/3	1.88E-06	--	--	--
AI34	2E-05	3E+01	3E+01	Metal	Arsenic	C	3 - 7.3	5.17E+00	11/13	3.19E-06	<1	11.1	No
					Lead	--	10 - 2700	2.70E+03	12/13	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.023 - 51	5.10E+01	17/18	1.38E-05	2E+01	--	--
AI35	4E-04	7E+02	7E+02	Metal	Arsenic	C	4.4 - 6.7	6.70E+00	3/4	4.13E-06	<1	11.1	No
					Lead	--	52 - 9700	9.70E+03	4/4	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	22.3 - 1500	1.50E+03	5/5	4.06E-04	7E+02	--	--
					Dieldrin	C	7.9 - 7.9	7.90E+00	1/4	1.39E-05	<1	--	--
AJ28	7E-05	4E+00	2E+00	Metal	Arsenic	C,NC	3.1 - 106	1.06E+02	3/3	6.54E-05	2E+00	11.1	Yes
					Lead	--	67.9 - 893	8.93E+02	3/3	--	--	8.99	Yes
AJ29	1E-05	3E+00	<1	Metal	Arsenic	C	2.6 - 22.5	2.25E+01	4/4	1.39E-05	<1	11.1	Yes
AJ30	1E-05	3E+00	<1	Metal	Arsenic	C	6.4 - 6.4	6.40E+00	1/4	3.95E-06	<1	11.1	No
					Lead	--	119 - 5760	5.76E+03	2/4	--	--	8.99	Yes
				PAH	Benzo(a)pyrene	C	3.4 - 3.4	3.40E+00	1/4	5.26E-06	--	--	--

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals: HPAL	Metals: Maximum Concentration Exceeds HPAL?
AJ31	1E-05	8E+00	6E+00	Metal	Antimony	NC	3.9 - 762	7.62E+02	2/6	--	6E+00	9.05	Yes
					Arsenic	C	4.1 - 24.5	1.51E+01	4/6	9.32E-06	<1	11.1	Yes
					Lead	--	11.3 - 113000	1.13E+05	6/6	--	--	8.99	Yes
AJ33	8E-06	2E+00	<1	Metal	Arsenic	C	3.8 - 4	4.00E+00	2/2	2.47E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	2.05 - 2.05	2.05E+00	1/2	3.17E-06	--	--	--
AJ34	5E-05	7E+01	7E+01	Metal	Arsenic	C	1.85 - 5.75	3.84E+00	10/12	2.37E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	0.0295 - 0.98	9.80E-01	6/12	1.52E-06	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.004 - 147	1.47E+02	23/25	3.97E-05	7E+01	--	--
					Dieldrin	C	0.019 - 5.7	2.22E+00	9/12	3.90E-06	<1	--	--
AJ35	6E-04	9E+02	8E+02	Metal	Arsenic	C	2.9 - 26	1.19E+01	13/13	7.32E-06	<1	11.1	Yes
				PAH	Benzo(a)pyrene	C	0.33 - 2.2	2.20E+00	5/13	3.41E-06	--	--	--
				Pest/PCB	4,4'-DDT	C	0.0054 - 110	1.10E+02	7/13	2.44E-06	<1	--	--
					Aroclor-1260	C,NC	0.0089 - 12000	1.70E+03	20/21	4.61E-04	8E+02	--	--
					Dieldrin	C	0.8 - 2.2	2.20E+00	2/13	3.87E-06	<1	--	--
					Heptachlor epoxide	C,NC	0.21 - 86	8.60E+01	6/13	8.60E-05	5E+01	--	--
AJ36	2E-04	4E+02	4E+02	Metal	Arsenic	C	4.1 - 17	1.26E+01	7/8	7.75E-06	<1	11.1	Yes
				PAH	Benzo(a)pyrene	C	0.28 - 1.1	1.10E+00	6/8	1.70E-06	--	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.25 - 750	7.50E+02	9/9	2.03E-04	4E+02	--	--
					Heptachlor epoxide	C,NC	0.0032 - 8.7	8.70E+00	6/8	8.70E-06	5E+00	--	--
AK29	9E-06	9E+00	3E+00	Metal	Antimony	NC	7.5 - 409	4.09E+02	7/9	--	3E+00	9.05	Yes
					Arsenic	C	0.6 - 20.6	1.20E+01	8/11	7.38E-06	<1	11.1	Yes
					Lead	--	1.6 - 6920	6.92E+03	11/11	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	NC	0.05 - 8.9	4.82E+00	5/11	1.31E-06	2E+00	--	--
AK30	1E-05	9E+00	7E+00	Metal	Arsenic	C	0.92 - 9.9	9.90E+00	5/9	6.10E-06	<1	11.1	No
					Lead	--	1.6 - 11200	1.12E+04	9/9	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	2.6 - 14	1.40E+01	3/9	3.79E-06	7E+00	--	--
AK31	7E-06	1E+01	7E+00	Metal	Antimony	NC	6.5 - 976	9.06E+02	7/12	--	7E+00	9.05	Yes
					Arsenic	C	2.5 - 14.1	7.14E+00	7/12	4.40E-06	<1	11.1	No
					Lead	--	3 - 256000	2.56E+05	8/12	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.15 - 25	6.49E+00	6/12	1.76E-06	3E+00	--	--

Table 7-9. Total Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI	Metals: HPAL	Metals: Maximum Concentration Exceeds HPAL?
AK32	5E-05	7E+01	7E+01	Metal	Arsenic	C	1.8 - 10.4	6.88E+00	8/9	4.24E-06	<1	11.1	No
					Lead	--	4.6 - 5570	5.57E+03	9/9	--	--	8.99	Yes
				Pest/PCB	Aroclor-1260	C,NC	1.5 - 150	1.50E+02	6/9	4.06E-05	7E+01	--	--
AK34	7E-05	1E+02	1E+02	Metal	Arsenic	C	1.4 - 12.7	1.27E+01	6/6	7.80E-06	<1	11.1	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.015 - 240	2.40E+02	20/20	6.50E-05	1E+02	--	--
AK35	3E-06	6E+00	6E+00	Pest/PCB	Aroclor-1260	C,NC	0.008 - 12	1.20E+01	18/19	3.25E-06	6E+00	--	--
AK36	2E-05	2E+01	1E+01	Metal	Arsenic	C	2.4 - 22	1.22E+01	8/10	7.52E-06	<1	11.1	Yes
				Pest/PCB	Aroclor-1260	C,NC	0.016 - 220	2.51E+01	15/23	6.80E-06	1E+01	--	--
AK37	1E-05	7E+00	6E+00	Metal	Arsenic	C	2.9 - 13	1.14E+01	4/4	7.05E-06	<1	11.1	Yes
				PAH	Benzo(a)pyrene	C	0.23 - 1.2	1.20E+00	2/4	1.86E-06	--	--	--
				Pest/PCB	Aroclor-1248	NC	3.8 - 3.8	3.80E+00	1/5	1.03E-06	2E+00	--	--
					Aroclor-1260	C,NC	0.41 - 9.8	7.76E+00	5/5	2.10E-06	4E+00	--	--
AL33	6E-06	3E+00	<1	Metal	Arsenic	C	2.9 - 7	6.46E+00	5/5	3.99E-06	<1	11.1	No
AL34	7E-06	4E+00	2E+00	Metal	Arsenic	C	2 - 7.4	5.40E+00	11/12	3.33E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	0.016 - 1.1	1.10E+00	7/12	1.70E-06	--	--	--
				Pest/PCB	Aroclor-1260	NC	0.047 - 5.2	4.06E+00	10/15	1.10E-06	2E+00	--	--
AL36	2E-05	1E+01	1E+01	Pest/PCB	Aroclor-1260	C,NC	0.019 - 21	2.10E+01	7/9	5.69E-06	1E+01	--	--
				Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/1	1.91E-06	<1	11.1	No
				PAH	Benzo(a)pyrene	C	4.5 - 4.5	4.50E+00	1/1	6.97E-06	--	--	--

Notes: All concentrations shown in mg/kg.

--	Not applicable or chemical is not a chemical of concern for this endpoint	mg/kg	Milligram per kilogram
bgs	Below ground surface	NC	Noncancer effect
C	Cancer effect	PAH	Polycyclic aromatic hydrocarbon
DDT	Dichlorodiphenyltrichloroethane	PCB	Polychlorinated biphenyl
EPC	Exposure point concentration	Pest	Pesticide
HI	Hazard index	RME	Reasonable maximum exposure
HPAL	Hunters Point ambient level	TEQ	Toxic equivalency factor

Table 7-10. Incremental Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI
AA39	2E-04	2E+01	6E+00	Metal	Antimony	NC	10.4 - 530	5.30E+02	6/12	--	4E+00
					Arsenic	C,NC	3.3 - 315	3.15E+02	10/12	1.94E-04	5E+00
					Iron	NC	14000 - 217000	1.77E+05	12/12	--	2E+00
					Lead	--	24.7 - 9300	9.30E+03	11/12	--	--
					Vanadium	NC	17 - 620	6.20E+02	12/12	--	2E+00
				PAH	Naphthalene	C	1.2 - 120	1.20E+02	6/12	1.59E-06	<1
AB29	2E-06	6E+00	3E+00	Metal	Antimony	C,NC	0.12 - 350	3.50E+02	5/10	--	3E+00
				Pest/PCB	Aroclor-1016	NC	13 - 13	1.30E+01	1/10	1.23E-07	2E+00
AB33	1E-05	<1	<1	PAH	Benzo(a)pyrene	C,NC	6.9 - 6.9	6.90E+00	1/3	1.07E-05	--
AB36	7E-06	1E+01	1E+01	Metal	Lead	--	3.4 - 6270	2.55E+03	11/11	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.023 - 20	2.00E+01	2/9	5.41E-06	9E+00
					Total PCBs (Non-Dioxin)	NC	4.09 - 4.14	4.14E+00	2/2	1.12E-06	2E+00
AB39	2E-05	5E+00	2E+00	Metal	Antimony	NC	2.1 - 300	3.00E+02	5/6	--	2E+00
					Arsenic	C	3.4 - 30	2.38E+01	6/6	1.47E-05	<1
					Lead	--	39.7 - 5400	3.29E+03	6/6	--	--
				Dioxin	Dioxin (TEQ)	C	0.00000004 - 0.000523	4.38E-04	4/4	4.29E-06	--
AC29	9E-06	3E+01	2E+01	Pest/PCB	Aroclor-1016	NC	130 - 130	1.30E+02	1/3	1.23E-06	2E+01
					Aroclor-1260	C,NC	24 - 24	2.40E+01	1/3	6.50E-06	1E+01
AC30	1E-05	1E+02	1E+02	Metal	Lead	--	5.3 - 1020	1.02E+03	4/4	--	--
				PAH	Benzo(a)pyrene	C	0.05 - 2.4	2.40E+00	2/4	3.71E-06	--
				Pest/PCB	Aroclor-1016	C,NC	740 - 740	7.40E+02	1/4	7.01E-06	1E+02
AC33	6E-06	<1	<1	PAH	Benzo(a)pyrene	C,NC	0.051 - 1.9	1.90E+00	5/8	2.94E-06	--
AC34	7E-06	4E+00	3E+00	Metal	Iron	NC	16000 - 471000	2.63E+05	8/8	--	3E+00
				PAH	Benzo(a)pyrene	C	0.072 - 3.1	3.10E+00	6/8	4.80E-06	--
AC39	2E-05	5E+00	2E+00	Metal	Arsenic	C	14 - 23	2.11E+01	5/5	1.30E-05	<1
					Lead	--	420 - 2000	1.97E+03	5/5	--	--
					Manganese	NC	650 - 12000	1.20E+04	5/5	--	2E+00
AC40	1E-05	4E+00	2E+00	Metal	Arsenic	C	6.09 - 25	1.74E+01	9/9	1.08E-05	<1
					Lead	--	211 - 8600	4.68E+03	9/9	--	--

Table 7-10. Incremental Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI
AC41	9E-06	4E+00	2E+00	Metal	Arsenic	C	3.06 - 18	1.15E+01	8/8	7.12E-06	<1
					Copper	NC	50 - 27000	2.70E+04	8/8	--	2E+00
					Lead	--	87 - 1800	1.38E+03	8/8	--	--
AD29	1E-04	2E+02	2E+02	Metal	Arsenic	C	4.2 - 12.6	1.14E+01	4/4	7.02E-06	<1
				Pest/PCB	Aroclor-1254	C,NC	7.1 - 7.1	7.10E+00	1/2	1.92E-06	3E+00
					Aroclor-1260	C,NC	8.6 - 370	3.70E+02	2/2	1.00E-04	2E+02
AD32	3E-06	4E+00	<1	Metal	Lead	--	58 - 3840	3.36E+03	4/4	--	--
				PAH	Benzo(a)pyrene	C	0.052 - 1.1	1.10E+00	2/4	1.70E-06	--
AD33	8E-05	2E+01	1E+01	PAH	Benzo(a)anthracene	C	0.058 - 51	5.10E+01	6/8	7.89E-06	--
					Benzo(a)pyrene	C	0.059 - 16	1.60E+01	6/8	2.48E-05	--
					Benzo(b)fluoranthene	C	0.064 - 64	6.40E+01	7/8	9.91E-06	--
					Benzo(k)fluoranthene	C	0.058 - 53	5.30E+01	6/8	8.20E-06	--
					Dibenz(a,h)anthracene	C	5.3 - 5.3	5.30E+00	1/8	4.99E-06	--
					Indeno(1,2,3-cd)pyrene	C	0.053 - 17	1.70E+01	7/8	2.63E-06	--
				Pest/PCB	Aroclor-1248	C,NC	0.12 - 12	1.20E+01	2/8	3.25E-06	6E+00
					Aroclor-1254	C,NC	0.037 - 17	1.70E+01	2/8	4.60E-06	8E+00
					Dieldrin	C	3.2 - 6.4	6.40E+00	2/8	1.13E-05	<1
AD34	1E-05	1E+01	7E+00	Metal	Arsenic	C	2.8 - 13	1.06E+01	6/6	6.52E-06	<1
					Vanadium	NC	31 - 2100	1.08E+03	6/6	--	3E+00
				Pest/PCB	Aroclor-1260	C,NC	0.072 - 14	1.40E+01	5/6	3.79E-06	7E+00
AE31	3E-05	4E+01	2E+01	Metal	Antimony	NC	42.5 - 1930	1.93E+03	2/2	--	2E+01
					Arsenic	C	3 - 47.8	4.78E+01	4/4	2.95E-05	<1
					Copper	NC	42 - 167000	1.67E+05	4/4	--	1E+01
				Pest/PCB	Aroclor-1242	C,NC	0.024 - 7.2	6.20E+00	4/4	1.68E-06	3E+00
AF28	2E-06	4E+00	3E+00	Pest/PCB	Aroclor-1260	C,NC	0.056 - 7.2	7.20E+00	2/2	1.95E-06	3E+00
AF32	2E-06	<1	<1		No Chemicals of Concern Identified						
AF33	8E-06	<1	<1	Metal	Arsenic	C	11.3 - 12.2	1.22E+01	2/2	7.52E-06	<1
AG31	3E-06	<1	<1	PAH	Benzo(a)pyrene	C,NC	1.3 - 1.3	1.30E+00	1/4	2.01E-06	--

Table 7-10. Incremental Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI
AG32	1E-05	<1	<1	Metal	Arsenic	C	4 - 17.4	1.57E+01	4/4	9.67E-06	<1
				PAH	Benzo(a)pyrene	C	0.18 - 1.1	1.10E+00	2/4	1.70E-06	--
AG34	1E-04	2E+02	2E+02	PAH	Benzo(a)pyrene	C	0.0088 - 3.1	1.29E+00	12/15	1.99E-06	--
				Metal	Lead	--	14 - 1800	1.80E+03	15/15	--	--
				Pest/PCB	Aroclor-1242	C,NC	15 - 15	1.50E+01	1/15	4.06E-06	7E+00
					Aroclor-1260	C,NC	0.038 - 380	3.20E+02	13/15	8.67E-05	2E+02
AH29	3E-06	<1	<1	PAH	Benzo(a)pyrene	C,NC	1.1 - 1.1	1.10E+00	1/5	1.70E-06	--
AH32	1E-04	1E+02	7E+01	Metal	Antimony	NC	487 - 675	6.75E+02	2/2	--	5E+00
					Arsenic	C	3.2 - 66.6	5.75E+01	4/4	3.54E-05	<1
					Cadmium	NC	10.3 - 330	3.30E+02	2/4	1.05E-08	2E+00
					Copper	NC	55.5 - 175000	1.52E+05	4/4	--	1E+01
					Iron	NC	30200 - 165000	1.47E+05	4/4	--	2E+00
					Lead	--	7.7 - 3720	3.64E+03	4/4	--	--
					Vanadium	NC	58.3 - 24900	2.09E+04	4/4	--	7E+01
				PAH	Benzo(a)anthracene	C	1.3 - 80	8.00E+01	2/4	1.24E-05	--
					Benzo(a)pyrene	C	0.13 - 16	1.60E+01	2/4	2.48E-05	--
					Benzo(b)fluoranthene	C	0.52 - 43	4.30E+01	2/4	6.66E-06	--
					Benzo(k)fluoranthene	C	0.11 - 13	1.30E+01	2/4	2.01E-06	--
					Naphthalene	C,NC	2.2 - 1400	1.40E+03	2/4	1.86E-05	8E+00
AH33	2E-05	4E+00	2E+00	PAH	Benzo(a)anthracene	C,NC	0.1 - 11	1.10E+01	3/4	1.70E-06	--
					Benzo(a)pyrene	C,NC	0.1 - 7.5	7.50E+00	3/4	1.16E-05	--
					Benzo(b)fluoranthene	C,NC	0.13 - 10	1.00E+01	3/4	1.55E-06	--
				Pest/PCB	Aroclor-1260	NC	1.6 - 3.4	3.40E+00	2/4	9.20E-07	2E+00
AH34	2E-05	3E+01	2E+01	Metal	Antimony	NC	0.34 - 400	4.00E+02	12/13	--	3E+00
					Lead	--	4.1 - 2200	1.04E+03	13/13	--	--
				PAH	Benzo(a)pyrene	C	0.013 - 3	2.05E+00	12/13	3.17E-06	--
				Pest/PCB	Aroclor-1254	NC	0.29 - 5.1	5.10E+00	7/18	1.38E-06	2E+00
					Aroclor-1260	C,NC	0.03 - 94	3.93E+01	18/18	1.06E-05	2E+01

Table 7-10. Incremental Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI
AI28	3E-05	<1	<1	PAH	Benzo(a)pyrene	C	12 - 12	1.20E+01	1/3	1.86E-05	--
					Benzo(b)fluoranthene	C	17 - 17	1.70E+01	1/3	2.63E-06	--
					Dibenz(a,h)anthracene	C	2 - 2	2.00E+00	1/3	1.88E-06	--
AI34	2E-05	3E+01	3E+01	Metal	Lead	--	10 - 2700	2.70E+03	12/13	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.023 - 51	5.10E+01	17/18	1.38E-05	2E+01
AI35	4E-04	7E+02	7E+02	Metal	Lead	--	52 - 9700	9.70E+03	4/4	--	--
				Pest/PCB	Aroclor-1260	C,NC	22.3 - 1500	1.50E+03	5/5	4.06E-04	7E+02
					Dieldrin	C	7.9 - 7.9	7.90E+00	1/4	1.39E-05	<1
AJ28	7E-05	3E+00	2E+00	Metal	Arsenic	C,NC	3.1 - 106	1.06E+02	3/3	6.54E-05	2E+00
					Lead	--	67.9 - 893	8.93E+02	3/3	--	--
AJ29	1E-05	<1	<1	Metal	Arsenic	C	2.6 - 22.5	2.25E+01	4/4	1.39E-05	<1
AJ30	7E-06	2E+00	<1	Metal	Lead	--	119 - 5760	5.76E+03	2/4	--	--
				PAH	Benzo(a)pyrene	C	3.4 - 3.4	3.40E+00	1/4	5.26E-06	--
AJ31	1E-05	8E+00	6E+00	Metal	Antimony	NC	3.9 - 762	7.62E+02	2/6	--	6E+00
					Arsenic	C	4.1 - 24.5	1.51E+01	4/6	9.32E-06	<1
					Lead	--	11.3 - 113000	1.13E+05	6/6	--	--
AJ33	6E-06	2E+00	<1	PAH	Benzo(a)pyrene	C,NC	2.05 - 2.05	2.05E+00	1/2	3.17E-06	--
AJ34	5E-05	7E+01	7E+01	PAH	Benzo(a)pyrene	C	0.0295 - 0.98	9.80E-01	6/12	1.52E-06	--
				Pest/PCB	Aroclor-1260	C,NC	0.004 - 147	1.47E+02	23/25	3.97E-05	7E+01
					Dieldrin	C	0.019 - 5.7	2.22E+00	9/12	3.90E-06	<1
AJ35	6E-04	9E+02	8E+02	Metal	Arsenic	C	2.9 - 26	1.19E+01	13/13	7.32E-06	<1
				PAH	Benzo(a)pyrene	C	0.33 - 2.2	2.20E+00	5/13	3.41E-06	--
				Pest/PCB	4,4'-DDT	C	0.0054 - 110	1.10E+02	7/13	2.44E-06	<1
					Aroclor-1260	C,NC	0.0089 - 12000	1.70E+03	20/21	4.61E-04	8E+02
					Dieldrin	C	0.8 - 2.2	2.20E+00	2/13	3.87E-06	<1
					Heptachlor epoxide	C,NC	0.21 - 86	8.60E+01	6/13	8.60E-05	5E+01
AJ36	2E-04	4E+02	4E+02	Metal	Arsenic	C	4.1 - 17	1.26E+01	7/8	7.75E-06	<1
				PAH	Benzo(a)pyrene	C	0.28 - 1.1	1.10E+00	6/8	1.70E-06	--
				Pest/PCB	Aroclor-1260	C,NC	0.25 - 750	7.50E+02	9/9	2.03E-04	4E+02
					Heptachlor epoxide	C,NC	0.0032 - 8.7	8.70E+00	6/8	8.70E-06	5E+00

Table 7-10. Incremental Risk: Risk Characterization Analysis for Subsurface Soil (0 to 10 feet bgs), Construction Worker Scenario *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI		Chemicals of Concern	Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-specific HI
AK29	9E-06	8E+00	3E+00	Metal	Antimony	NC	7.5 - 409	4.09E+02	7/9	--	3E+00
					Arsenic	C	0.6 - 20.6	1.20E+01	8/11	7.38E-06	<1
					Lead	--	1.6 - 6920	6.92E+03	11/11	--	--
				Pest/PCB	Aroclor-1260	NC	0.05 - 8.9	4.82E+00	5/11	1.31E-06	2E+00
AK30	4E-06	8E+00	7E+00	Metal	Lead	--	1.6 - 11200	1.12E+04	9/9	--	--
				Pest/PCB	Aroclor-1260	C,NC	2.6 - 14	1.40E+01	3/9	3.79E-06	7E+00
AK31	7E-06	1E+01	7E+00	Metal	Antimony	NC	6.5 - 976	9.06E+02	7/12	--	7E+00
					Arsenic	C	2.5 - 14.1	7.14E+00	7/12	4.40E-06	<1
					Lead	--	3 - 256000	2.56E+05	8/12	--	--
				Pest/PCB	Aroclor-1260	C,NC	0.15 - 25	6.49E+00	6/12	1.76E-06	3E+00
AK32	4E-05	7E+01	7E+01	Metal	Lead	--	4.6 - 5570	5.57E+03	9/9	--	--
				Pest/PCB	Aroclor-1260	C,NC	1.5 - 150	1.50E+02	6/9	4.06E-05	7E+01
AK34	7E-05	1E+02	1E+02	Metal	Arsenic	C	1.4 - 12.7	1.27E+01	6/6	7.80E-06	<1
				Pest/PCB	Aroclor-1260	C,NC	0.015 - 240	2.40E+02	20/20	6.50E-05	1E+02
AK35	3E-06	6E+00	6E+00	Pest/PCB	Aroclor-1260	C,NC	0.008 - 12	1.20E+01	18/19	3.25E-06	6E+00
AK36	2E-05	1E+01	1E+01	Metal	Arsenic	C	2.4 - 22	1.22E+01	8/10	7.52E-06	<1
				Pest/PCB	Aroclor-1260	C,NC	0.016 - 220	2.51E+01	15/23	6.80E-06	1E+01
AK37	1E-05	7E+00	6E+00	Metal	Arsenic	C	2.9 - 13	1.14E+01	4/4	7.05E-06	<1
				PAH	Benzo(a)pyrene	C	0.23 - 1.2	1.20E+00	2/4	1.86E-06	--
				Pest/PCB	Aroclor-1248	NC	3.8 - 3.8	3.80E+00	1/5	1.03E-06	2E+00
					Aroclor-1260	C,NC	0.41 - 9.8	7.76E+00	5/5	2.10E-06	4E+00
AL33	2E-06	2E+00	<1	No Chemicals of Concern Identified							
AL34	4E-06	2E+00	2E+00	PAH	Benzo(a)pyrene	C	0.016 - 1.1	1.10E+00	7/12	1.70E-06	--
				Pest/PCB	Aroclor-1260	NC	0.047 - 5.2	4.06E+00	10/15	1.10E-06	2E+00
AL36	2E-05	1E+01	1E+01	PAH	Benzo(a)pyrene	C	4.5 - 4.5	4.50E+00	1/1	6.97E-06	--
				Pest/PCB	Aroclor-1260	C,NC	0.019 - 21	2.10E+01	7/9	5.69E-06	1E+01

Notes:	All concentrations shown in mg/kg.
--	Not applicable or chemical is not a chemical of concern for this endpoint
<1	Less than 1
bgs	Below ground surface
C	Cancer effect
DDT	Dichlorodiphenyltrichloroethane
EPC	Exposure point concentration
HI	Hazard index
HPAL	Hunters Point ambient level
mg/kg	Milligram per kilogram
NC	Noncancer effect
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
Pest	Pesticide
RME	Reasonable maximum exposure
TEQ	Toxic equivalency factor

Table 7-11. Risk Characterization Analysis for B-Aquifer Groundwater Based on Domestic Use
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Exposure Area	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Exposure Pathway	Source Aquifer for Exposure Pathway	Total RME Cancer Risk for Exposure Pathway	Total RME HI for Exposure Pathway		Chemical of Concern	Basis for Chemical of Concern	Detection Frequency	RME Concentration (µg/L)	Chemical-Specific Cancer Risk	Percent Contribution to Total RME Cancer Risk for Exposure Pathway	Chemical-Specific HI	Percent Contribution to Total RME HI for Exposure Pathway
Parcel E-2	5E-03	8E+01	6E+01	Domestic Use	B[a]	5E-03	8E+01	Metal	Arsenic	C, NC	150/372	1.6E+01	2.3E-03	46.1%	1.5E+00	1.9%
									Iron	NC	127/178	2.3E+04	--	--	2.1E+00	2.7%
									Chromium VI	NC	1/131	1.3E+02	--	--	1.2E+00	1.6%
									Thallium	NC	11/360	2.5E+00	--	--	1.0E+00	1.3%
								PAH	Benzo(a)anthracene	C	7/375	3.5E+00	6.3E-05	1.3%	--	--
									Benzo(a)pyrene	C	4/373	3.5E+00	6.3E-04	12.8%	--	--
									Benzo(b)fluoranthene	C	5/373	6.0E+00	1.1E-04	2.2%	--	--
									Benzo(k)fluoranthene	C	1/373	1.1E+00	2.0E-05	0.4%	--	--
									Indeno(1,2,3-cd)pyrene	C	3/373	3.0E+00	5.4E-05	1.1%	--	--
									Chrysene	C	13/375	2.9E+00	5.1E-06	0.1%	--	--
									Dibenz(a,h)anthracene	C	1/373	1.3E+00	1.4E-04	2.9%	--	--
								Pest/PCB	Aroclor-1016	C, NC	2/351	3.4E+00	3.5E-06	0.1%	1.3E+00	1.7%
									Aroclor-1242	C, NC	5/351	4.0E+01	1.2E-03	24.1%	5.5E+01	71.9%
									Aroclor-1254	C, NC	6/351	6.5E-01	1.9E-05	0.4%	<1	--
									Aroclor-1260	C, NC	40/351	1.2E+00	3.7E-05	0.7%	1.7E+00	2.2%
									Beta-BHC	C, NC	4/343	6.5E-02	1.7E-06	0.04%	<1	--
									Dieldrin	C, NC	5/343	1.3E-01	3.0E-05	0.6%	<1	--
									Heptachlor	C, NC	9/343	1.9E-02	1.3E-06	0.0%	<1	--
									Heptachlor epoxide	C, NC	3/322	6.6E-02	8.9E-06	0.2%	<1	--
									Heptachlor epoxide A	C, NC	4/41	3.7E-02	5.0E-06	0.1%	<1	--
									Heptachlor epoxide B	C, NC	3/41	1.5E-02	2.0E-06	0.04%	<1	--
								SVOC	4-Nitrophenol	NC	1/373	7.5E+00	--	--	2.2E+00	2.9%
									Bis(2-ethylhexyl)phthalate	C, NC	2/375	1.6E+02	3.3E-05	0.7%	<1	--
								VOC	1,1-Dichloroethane	C, NC	27/394	3.6E+00	1.8E-06	0.04%	<1	--
									1,2,3-Trichloropropane	C, NC	1/300	5.5E-01	9.8E-05	2.0%	<1	--
									1,2-Dichloroethane	C, NC	27/394	4.4E-01	3.6E-06	0.1%	<1	--
									1,4-Dichlorobenzene	C, NC	63/395	1.1E+00	3.8E-06	0.1%	<1	--
									Benzene	C, NC	105/394	1.1E+00	1.0E-05	0.2%	<1	--
									Carbon tetrachloride	C, NC	1/394	3.0E+00	4.1E-05	0.8%	<1	--
									Chloroform	C, NC	16/394	2.6E-01	1.7E-06	0.04%	<1	--
									Methylene Chloride	C, NC	2/394	3.0E+00	1.4E-06	0.03%	<1	--
									Naphthalene	C, NC	42/375	7.5E+00	8.0E-05	1.6%	1.2E+00	1.6%
									Tetrachloroethene	C, NC	21/394	4.9E+00	4.7E-05	1.0%	<1	--
									Trichloroethene	C, NC	23/394	4.6E+00	3.3E-06	0.1%	<1	--
									Vinyl chloride	C, NC	18/394	5.5E-01	1.7E-05	0.4%	<1	--

Notes: All concentrations shown in micrograms per liter (µg/L).

a As indicated in Section K3.5.2 of Appendix K, the domestic use evaluation for the B-aquifer included data from the A-aquifer.

-- Not applicable or chemical is not a chemical of concern for this endpoint
<1 Less than 1
BHC Benzenehexachloride
C Cancer effect
HI Hazard index
NC Noncancer effect
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
Pest Pesticide
RME Reasonable maximum exposure
SVOC Semivolatile organic compound
VOC Volatile organic compound

Table 7-12. Lead Evaluation for Groundwater

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Chemical of Potential Concern	Aquifer	Location of Maximum	Detection Frequency	Maximum Concentration	95 UCL	RME EPC	California Regulatory Action Level	Maximum Detected Concentration Exceeds Action Level?	RME EPC Exceeds Action Level?
Lead	B [a]	IR01MWI-9	74 / 371	6,520	1.4E+02	140	15	Yes	Yes

Notes: All concentrations shown in micrograms per liter (µg/L).

a As indicated in Section K3.5.2 of Appendix K, the domestic use evaluation for the B-aquifer included data from the A-aquifer.

95 UCL One-sided 95 percent upper confidence limit of the mean

EPC Exposure point concentration

RME Reasonable maximum exposure

Table 7-13. Remediation Goals for Chemicals of Concern in Soil
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Exposure Scenario	Chemical of Concern[a]	Risk-Based Concentration	Hunters Point Ambient Level	Practical Quantitation Limit	Remediation Goal
Recreational	Antimony	270	9.05	0.5	270
	Aroclor-1242	0.74	--	0.01	0.74
	Aroclor-1248	0.74	--	0.01	0.74
	Aroclor-1254	0.74	--	0.01	0.74
	Aroclor-1260	0.74	--	0.01	0.74
	Arsenic	0.37	11.1	0.2	11.1
	Benzo(a)anthracene	1.3	--	0.33	1.3
	Benzo(a)pyrene	0.13	--	0.33	0.33
	Benzo(b)fluoranthene	1.3	--	0.33	1.3
	Benzo(k)fluoranthene	1.3	--	0.33	1.3
	Dieldrin	0.12	--	0.004	0.12
	Heptachlor epoxide	0.21	--	0.0017	0.21
	Indeno(1,2,3-cd)pyrene	1.3	--	0.33	1.3
	Lead	155	8.99	0.6	155
	Total PCBs (Non-Dioxin) [b]	0.74	--	0.01	0.74
Construction Worker	4,4'-DDT	45	--	0.004	45
	Antimony	120	9.05	0.5	120
	Aroclor-1016	7.4	--	0.01	7.4
	Aroclor-1242	2.1	--	0.01	2.1
	Aroclor-1248	2.1	--	0.01	2.1
	Aroclor-1254	2.1	--	0.01	2.1
	Aroclor-1260	2.1	--	0.01	2.1
	Arsenic	1.62	11.1	0.2	11.1
	Benzo(a)anthracene	6.5	--	0.33	6.5
	Benzo(a)pyrene	0.65	--	0.33	0.65
	Benzo(b)fluoranthene	6.5	--	0.33	6.5
	Benzo(k)fluoranthene	6.5	--	0.33	6.5
	Cadmium	150	3.14	0.04	150
	Copper	11,000	124.31	0.1	11,000
	Dibenz(a,h)anthracene	1.1	--	0.33	1.1
	Dieldrin	0.57	--	0.004	0.57
	Dioxin (TEQ) [c]	0.000023	--	0.000001	0.000023
	Heptachlor epoxide	1	--	0.0017	1
	Indeno(1,2,3-cd)pyrene	6.5	--	0.33	6.5
	Iron	93,000	58,000	0.6	93,000
	Lead	800	8.99	0.6	800
	Manganese	6,900	1,431	0.5	6,900
	Naphthalene	75	--	0.004	75
	Total PCBs (Non-Dioxin) [b]	2.1	--	0.01	2.1
	Vanadium	310	117.17	0.1	310

Notes: All concentrations shown in milligrams per kilogram.

a Chemicals of concern are based on the results of the incremental risk evaluation for soil.
b Aroclor-1254 was used as a surrogate.
c 2,3,7,8-Tetrachlorodibenzo-p-dioxin was used as a surrogate.

-- Not applicable
DDT Dichlorodiphenyltrichloroethane
PCB Polychlorinated biphenyl
TEQ Toxic equivalency quotient

Table 7-14. Remedial Goals for Chemicals of Concern in A-Aquifer Groundwater
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Exposure Scenario	Chemical of Concern	Risk-Based Concentration	Hunters Point Groundwater Ambient Level	Practical Quantitation Limit	Remediation Goal
Construction Worker	Benzo(a)anthracene	0.67	--	0.05	0.67
	Benzo(a)pyrene	0.045	--	0.05	0.05
	Benzo(b)fluoranthene	0.45	--	0.05	0.45
	Benzo(k)fluoranthene	0.45	--	0.05	0.45
	Dibenz(a,h)anthracene	0.034	--	0.05	0.05
	Indeno(1,2,3-cd)pyrene	0.31	--	0.05	0.31
	Lead	15	14.44	1	15

Notes: All concentrations shown in micrograms per liter.

-- Not applicable

Table 7-15. Remediation Goals for Chemicals of Concern in B-Aquifer Groundwater
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Exposure Scenario	Chemical of Concern	Risk-Based Concentration	Hunters Point Groundwater Ambient Level	Practical Quantitation Limit	Maximum Contaminant Level[a]	Remediation Goal
Domestic Use	1,1-Dichloroethane	2.0	--	0.5	5[b]	5
	1,2,3-Trichloropropane	0.0056	--	1	NA	1
	1,2-Dichloroethane	0.12	--	0.5	0.5[b]	0.5
	1,4-Dichlorobenzene	0.30	--	1	5[b]	5
	4-Nitrophenol	3.4	--	0.5	NA	3.4
	Aroclor-1016	1.0	--	0.2	0.5[c,d]	0.5
	Aroclor-1242	0.034	--	0.2	0.5[c,d]	0.5
	Aroclor-1254	0.034	--	0.2	0.5[c,d]	0.5
	Aroclor-1260	0.034	--	0.2	0.5[c,d]	0.5
	Arsenic	0.0070	27.3	1	10[e]	10
	Benzene	0.11	--	0.5	1[b]	1
	Benzo(a)anthracene	0.055	--	0.05	0.2[c,f]	0.2
	Benzo(a)pyrene		--	0.05	0.2[c]	0.2
	Benzo(b)fluoranthene	0.056	--	0.05	0.2[c,f]	0.2
	Benzo(k)fluoranthene	0.056	--	0.05	0.2[c,f]	0.2
	Bis(2-ethylhexyl)phthalate	4.802	--	10	4[b]	10
	beta-BHC	0.037	--	0.05	NA	0.05
	Carbon tetrachloride	0.074	--	0.5	0.5[b]	0.5
	Chloroform	0.15	--	1	80[c,g]	80
	Chromium VI	109	--	10	NA	109
	Chrysene	0.56	--	0.05	0.2[c,f]	0.56
	Dibenz(a,h)anthracene	0.0092	--	0.05	0.2[c,f]	0.2
	Dieldrin	0.0042	--	0.02	NA	0.02
	Heptachlor	0.015	--	0.01	0.01[b]	0.01
	Heptachlor epoxide	0.0074	--	0.01	0.01[b]	0.01
	Heptachlor epoxide A	0.0074	--	0.01	0.01[b,i]	0.01
	Heptachlor epoxide B	0.0074	--	0.01	0.01[b,i]	0.01
	Indeno(1,2,3-cd)pyrene	0.055	--	0.05	0.2[c,f]	0.2
	Iron	10,950	2,380	50	NA[j]	10,950
	Lead	15	14	1	15[k]	15
	Methylene Chloride	2.1	--	0.5	5[c]	5
	Naphthalene	0.093	--	1	NA	1
	Tetrachloroethene	0.1	--	1	5[c]	5
	Thallium	2.4	12.97	10	2[c]	2
	Trichloroethene	1.4	--	1	5[c]	5
	Vinyl chloride	0.032	--	0.5	0.5[b]	0.5

Table 7-15. Remediation Goals for Chemicals of Concern in B-Aquifer Groundwater *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Notes: All concentrations shown in micrograms per liter.

a Primary MCLs are provided for chemicals of concern for the domestic use exposure scenario. For each chemical, the MCL shown is the lowest between the federal and state of California MCL.
b Value shown is the state of California MCL.
c Value shown is both the federal and state of California MCL (federal and state regulatory standard is the same).
d Value shown is for polychlorinated biphenyls.
e Value shown is the Federal MCL.
f Value shown is for benzo(a)pyrene.
g Value shown is for total trihalomethanes.
h Value shown is for chlordane.
i Value shown is for heptachlor epoxide.
j A primary MCL is not available for iron; the federal secondary MCL for iron is 300 micrograms per liter.
k Value shown is the federal and state of California regulatory action level for lead in groundwater.

-- Not applicable
BHC Benzene hexachloride
MCL Maximum contaminant level
NA Not available

Table 7-16. Risk and Hazard Drivers and Associated Sampling Locations Exceeding Remediation Goals for Recreational Receptor Scenario, Surface Soil (0 to 2 feet bgs)
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI		Chemicals of Concern	Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Significant Sampling Information: Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
AA38	9E-08	<1	<1	Metal	Lead	--	--	1/1	1.86E+02	1.55E+02	IR01B365	1.25	1.25	186
AA39	6E-04	5E+00	2E+00	Metal	Antimony	--	1.94E+00	2/5	5.30E+02	2.70E+02	IR01B368	1	2	530
					Arsenic	5.79E-04	1.60E+00	3/5	2.15E+02	1.11E+01	IR01B368	1	2	36
											IR01MW58A	1.25	1.25	215
					Lead	--	--	4/5	4.90E+03	1.55E+02	IR01B368	1	2	4,900
											IR01MW58A	1.25	1.25	379
				PAH	Benzo(a)pyrene	2.37E-06	--	1/5	3.10E-01	3.30E-01	No samples exceed remediation goals			
AB29	3E-06	<1	<1	PAH	Benzo(a)pyrene	1.99E-06	--	1/2	2.60E-01	3.30E-01	No samples exceed remediation goals			
AB36	3E-05	6E+00	6E+00	Metal	Lead	--	--	6/6	6.27E+03	1.55E+02	IR01B372	1	2	300
											IR01SW2	0	0.5	6,200
				Pest/PCB	Aroclor-1260	2.69E-05	5.04E+00	2/4	2.00E+01	7.40E-01	IR01B372	1	2	20
					PCB-044 [a]	5.58E-06	<1	2/2	4.14E+00	7.40E-01	IR01SW2	0	0.5	0.017
					PCB-052 [a]					7.40E-01	IR01SW2	0	0.5	0.045
					PCB-101 [a]					7.40E-01	IR01SW2	0	0.5	0.33
					PCB-128 [a]					7.40E-01	IR01SW2	0	0.5	0.0595
					PCB-138 [a]					7.40E-01	IR01SW2	0	0.5	1
					PCB-153 [a]					7.40E-01	IR01SW2	0	0.5	1
					PCB-170 [a]					7.40E-01	IR01SW2	0	0.5	0.535
					PCB-180 [a]					7.40E-01	IR01SW2	0	0.5	0.515
					PCB-187 [a]					7.40E-01	IR01SW2	0	0.5	0.45
					PCB-195 [a]					7.40E-01	IR01SW2	0	0.5	0.0795
					PCB-206 [a]					7.40E-01	IR01SW2	0	0.5	0.0295
					PCB-209 [a]					7.40E-01	IR01SW2	0	0.5	0.0555
AB39	4E-08	<1	<1	Metal	Lead	--	--	3/3	2.22E+02	1.55E+02	IR01PH1	0	0.5	220.5
AC29	5E-06	<1	<1	PAH	Benzo(a)pyrene	3.90E-06	--	1/1	5.10E-01	3.30E-01	IR01B004	1.91	1.91	0.51
AC30	3E-05	<1	<1	PAH	Benzo(a)pyrene	1.84E-05	--	1/1	2.40E+00	3.30E-01	IR01MW16A	1.25	1.25	2.4
					Benzo(b)fluoranthene	2.37E-06	--	1/1	3.10E+00	1.30E+00	IR01MW16A	1.25	1.25	3.1
					Indeno(1,2,3-cd)pyrene	2.22E-06	--	1/1	2.90E+00	1.30E+00	IR01MW16A	1.25	1.25	2.9
AC32	4E-06	<1	<1	PAH	Benzo(a)pyrene	3.29E-06	--	1/1	4.30E-01	3.30E-01	IR01B030	1.75	1.75	0.43
AC33	3E-05	<1	<1	PAH	Benzo(a)anthracene	4.67E-06	--	3/4	6.10E+00	1.30E+00	IR01B383	1	2	1.4
											IR01B385	1	2	6.1
					Benzo(a)pyrene	1.45E-05	--	3/4	1.90E+00	3.30E-01	IR01B383	1	2	1.9
											IR01B385	1	2	0.74
					Benzo(b)fluoranthene	3.75E-06	--	3/4	4.90E+00	1.30E+00	IR01B383	1	2	2.1
											IR01B385	1	2	4.9
					Benzo(k)fluoranthene	3.06E-06	--	3/4	4.00E+00	1.30E+00	IR01B383	1	2	2.1
											IR01B385	1	2	4
AC34	3E-05	<1	<1	Metal	Lead	--	--	3/3	3.02E+02	1.55E+02	IR01B378	1	2	160
											IR01MW53B	1.25	1.25	302
				PAH	Benzo(a)pyrene	2.37E-05	--	3/3	3.10E+00	3.30E-01	IR01B378	1	2	3.1
											IR01B397	1	2	0.53
					Benzo(b)fluoranthene	2.83E-06	--	3/3	3.70E+00	1.30E+00	IR01B378	1	2	3.7
					Benzo(k)fluoranthene	3.29E-06	--	2/3	4.30E+00	1.30E+00	IR01B378	1	2	4.3

Table 7-16. Risk and Hazard Drivers and Associated Sampling Locations Exceeding Remediation Goals for Recreational Receptor Scenario, Surface Soil (0 to 2 feet bgs) *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI	Chemicals of Concern		Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Significant Sampling Information: Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
AC35	2E-06	<1	<1	No Chemicals of Concern Identified										
AC39	6E-05	2E+00	<1	Metal	Arsenic	6.19E-05	<1	2/2	2.30E+01	1.11E+01	GRID 86 SIDEWALL	1	1.6	23
											GRID 87	0	0	14
					Lead	--	--	2/2	2.00E+03	1.55E+02	GRID 86 SIDEWALL	1	1.6	2,000
											GRID 87	0	0	1,000
AC40	5E-05	2E+00	2E+00	Metal	Arsenic	4.05E-05	<1	4/4	1.51E+01	1.11E+01	GRID 71	0	0	16
											GRID 101	0	0	12
					Lead	--	--	4/4	7.42E+03	1.55E+02	GRID 70 SIDEWALL	0	0	1,000
											GRID 71	0	0	8,600
											GRID 96	0	0	1,700
											GRID 101	0	0	420
				Pest/PCB	Aroclor-1254	2.49E-06	<1	2/4	1.85E+00	7.40E-01	GRID 101	0	0	1.85
AC41	5E-05	2E+00	<1	Metal	Arsenic	4.65E-05	<1	4/4	1.73E+01	1.11E+01	GRID 68/69 SIDEWALL	0	0.5	12
											GRID 94	0	0.5	18
					Lead	--	--	4/4	1.80E+03	1.55E+02	GRID 68/69 SIDEWALL	0	0.5	1,500
											GRID 91	0	0	1,000
											GRID 92/93 SIDEWALL	1	1.5	1,600
											GRID 94	0	0.5	1,800
AC42	6E-07	<1	<1	Metal	Lead	--	--	5/5	2.57E+02	1.55E+02	No samples exceed remediation goals			
AD29	3E-06	<1	<1	PAH	Benzo(a)pyrene	2.30E-06	--	1/1	3.00E-01	3.30E-01	No samples exceed remediation goals			
AD32	1E-05	<1	<1	PAH	Benzo(a)pyrene	8.42E-06	--	1/1	1.10E+00	3.30E-01	IR01B029	1.25	1.25	1.1
AD33	2E-04	4E+00	3E+00	Metal	Lead	--	--	4/4	6.84E+02	1.55E+02	IR01B386	1	2	380
											IR01B389	1	2	220
											IR01B394	1	2	730
				PAH	Benzo(a)anthracene	4.06E-06	--	3/4	5.30E+00	1.30E+00	IR01B390	1	2	5.3
											IR01B394	1	2	4
					Benzo(a)pyrene	6.15E-05	--	4/4	8.04E+00	3.30E-01	IR01B386	1	2	3.2
											IR01B390	1	2	8.6
											IR01B394	1	2	3.8
					Benzo(b)fluoranthene	8.48E-06	--	4/4	1.11E+01	1.30E+00	IR01B386	1	2	4.4
											IR01B390	1	2	12
											IR01B394	1	2	4.7
					Benzo(k)fluoranthene	3.44E-06	--	4/4	4.50E+00	1.30E+00	IR01B386	1	2	4.5
											IR01B390	1	2	4.4
											IR01B394	1	2	3.9
					Indeno(1,2,3-cd)pyrene	6.14E-06	--	4/4	8.03E+00	1.30E+00	IR01B386	1	2	4.5
											IR01B390	1	2	8.3
											IR01B394	1	2	3.4
				Pest/PCB	Aroclor-1248	1.62E-05	3.02E+00	2/4	1.20E+01	7.40E-01	IR01B386	1	2	12
					Dieldrin	5.45E-05	<1	1/4	6.40E+00	1.20E-01	IR01B394	1	2	6.4
AD34	6E-05	4E+00	4E+00	Metal	Arsenic	3.50E-05	<1	3/3	1.30E+01	1.11E+01	IR01B374	1	2	13
					Lead	--	--	3/3	5.30E+02	1.55E+02	IR01B373	1	2	180
											IR01B374	1	2	530

Table 7-16. Risk and Hazard Drivers and Associated Sampling Locations Exceeding Remediation Goals for Recreational Receptor Scenario, Surface Soil (0 to 2 feet bgs) *(continued)*

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI	Chemicals of Concern		Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Significant Sampling Information			
											Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
AD34	6E-05	4E+00	4E+00	PAH	Benzo(a)pyrene	4.13E-06	--	3/3	5.40E-01	3.30E-01	IR01B373	1	2	0.54
(cont.)											IR01B396	1	2	0.34
				Pest/PCB	Aroclor-1260	1.88E-05	3.53E+00	2/3	1.40E+01	7.40E-01	IR01B374	1	2	14
AD41	1E-06	<1	<1	Metal	Lead	--	--	1/1	3.70E+02	1.55E+02	GRID 99	0	0.5	370
AE31	6E-06	<1	<1	PAH	Benzo(a)pyrene	4.29E-06	--	1/1	5.60E-01	3.30E-01	IR01B018G	1.25	1.25	0.56
AF32	9E-06	<1	<1	PAH	Benzo(a)pyrene	6.58E-06	--	1/1	8.60E-01	3.30E-01	IR01MW38A	1	1	0.86
AG32	1E-05	<1	<1	PAH	Benzo(a)pyrene	8.42E-06	--	1/1	1.10E+00	3.30E-01	IR01MW26B	1.25	1.25	1.1
AG34	4E-05	<1	<1	PAH	Benzo(a)anthracene	1.76E-06	--	1/2	2.30E+00	1.30E+00	IR01B275	1.25	1.25	2.3
					Benzo(a)pyrene	2.37E-05	--	1/2	3.10E+00	3.30E-01	IR01B275	1.25	1.25	3.1
					Benzo(b)fluoranthene	3.14E-06	--	1/2	4.10E+00	1.30E+00	IR01B275	1.25	1.25	4.1
					Indeno(1,2,3-cd)pyrene	2.37E-06	--	1/2	3.10E+00	1.30E+00	IR01B275	1.25	1.25	3.1
				Pest/PCB	Aroclor-1260	5.92E-06	<1	4/5	4.40E+00	7.40E-01	No samples exceed remediation goals			
AH29	1E-05	<1	<1	PAH	Benzo(a)pyrene	8.42E-06	--	1/1	1.10E+00	3.30E-01	IR01B011	1.25	1.25	1.1
AH34	9E-05	2E+01	2E+01	Pest/PCB	Aroclor-1242	3.90E-06	<1	1/5	2.90E+00	7.40E-01	No samples exceed remediation goals			
					Aroclor-1254	2.42E-06	<1	1/5	1.80E+00	7.40E-01	No samples exceed remediation goals			
					Aroclor-1260	8.07E-05	<1	5/5	5.99E+01	7.40E-01	No samples exceed remediation goals			
AI34	7E-06	<1	<1	Metal	Lead	--	--	5/5	1.67E+02	7.40E-01	GRID 81 SIDEWALL	1	1.5	2.9
				Pest/PCB	Aroclor-1260	7.14E-06	<1	6/6	5.30E+00	7.40E-01	No samples exceed remediation goals			
AI35	9E-05	2E+01	1E+01	Metal	Lead	--	--	2/2	9.70E+03	1.55E+02	84-GRID 86 SIDEWALL	1	1.4	370
											GRID 165 SIDEWALL	0	1.3	9,700
				PAH	Benzo(a)pyrene	5.89E-06	--	1/2	7.70E-01	3.30E-01	84-GRID 86 SIDEWALL	1	1.4	0.77
				Pest/PCB	Aroclor-1260	7.94E-05	1.49E+01	2/2	5.90E+01	7.40E-01	84-GRID 86 SIDEWALL	1	1.4	59
											GRID 165 SIDEWALL	0	1.3	48
					Heptachlor epoxide	2.66E-06	<1	2/2	5.50E-01	2.10E-01	84-GRID 86 SIDEWALL	1	1.4	0.55
											GRID 165 SIDEWALL	0	1.3	0.39
AJ29	2E-06	<1	<1		No Chemicals of Concern Identified									
AJ30	3E-05	<1	<1	Metal	Lead	--	--	1/1	5.76E+03	1.55E+02	IR01TA06B	1	1	5,760
				PAH	Benzo(a)anthracene	1.76E-06	--	1/1	2.30E+00	1.30E+00	IR01TA06B	1	1	2.3
					Benzo(a)pyrene	2.60E-05	--	1/1	3.40E+00	3.30E-01	IR01TA06B	1	1	3.4
					Benzo(b)fluoranthene	5.05E-06	--	1/1	6.60E+00	1.30E+00	IR01TA06B	1	1	6.6
					Benzo(k)fluoranthene	1.61E-06	--	1/1	2.10E+00	1.30E+00	IR01TA06B	1	1	2.1
AJ34	2E-05	4E+00	4E+00	Pest/PCB	Aroclor-1260	1.88E-05	<1	3/3	1.40E+01	7.40E-01	GRID 57-1 SIDEWALL	0.8	1.3	1.9
											GRID 37 SIDEWALL	1.1	1.6	5.1
											GRID 56 SIDEWALL	1.3	1.8	14
AJ35	6E-04	1E+02	1E+02	Metal	Lead	--	--	2/2	7.70E+02	1.55E+02	GRID 110 SIDEWALL	0	1.8	770
				PAH	Benzo(a)anthracene	2.53E-06	--	1/2	3.30E+00	1.30E+00	No samples exceed remediation goals			
					Benzo(a)pyrene	1.68E-05	--	1/2	2.20E+00	3.30E-01	No samples exceed remediation goals			
					Benzo(b)fluoranthene	1.53E-06	--	1/2	2.00E+00	1.30E+00	No samples exceed remediation goals			
					Benzo(k)fluoranthene	2.68E-06	--	1/2	3.50E+00	1.30E+00	No samples exceed remediation goals			
				Pest/PCB	Aroclor-1260	6.06E-04	1.13E+02	2/2	4.50E+02	7.40E-01	GRID 110 SIDEWALL	0	1.8	450
					Heptachlor epoxide	1.55E-05	<1	2/2	3.20E+00	2.10E-01	GRID 110 SIDEWALL	0	1.8	3.2

Table 7-16. Risk and Hazard Drivers and Associated Sampling Locations Exceeding Remediation Goals for Recreational Receptor Scenario, Surface Soil (0 to 2 feet bgs) *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

											Significant Sampling Information			
Grid Number	RME Cancer Risk	RME HI	RME Segregated HI		Chemicals of Concern	Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
AJ36	2E-04	3E+01	3E+01	Metal	Arsenic	4.58E-05	<1	2/2	1.70E+01	1.11E+01	GRID 127-1 SIDEWALL	0	1.8	17
					Lead	--	--	2/2	6.10E+02	1.55E+02	GRID 127-1 SIDEWALL	0	1.8	230
				PAH	Benzo(a)pyrene	4.06E-06	--	2/2	5.30E-01	3.30E-01	No samples exceed remediation goals			
				Pest/PCB	Aroclor-1260	1.62E-04	3.02E+01	2/2	1.20E+02	7.40E-01	GRID 127-1 SIDEWALL	0	1.8	1.9
					Heptachlor epoxide	4.02E-06	<1	2/2	8.30E-01	2.10E-01	No samples exceed remediation goals			
AK29	5E-05	5E+00	2E+00	Metal	Arsenic	3.39E-05	<1	4/4	1.26E+01	1.11E+01	IR04B030	1.25	1.25	12.6
					Lead	--	--	4/4	6.92E+03	1.55E+02	IR01SS350	0.5	0.5	514
											IR04B007	1.75	1.75	441
											IR04B030	1.25	1.25	6,920
				PAH	Benzo(a)pyrene	1.53E-06	--	1/4	2.00E-01	3.30E-01	No samples exceed remediation goals			
				Pest/PCB	Aroclor-1260	1.20E-05	2.24E+00	3/4	8.90E+00	7.40E-01	IR01SS350	0.5	0.5	1.4
											IR04B030	1.25	1.25	8.9
AK30	2E-05	4E+00	4E+00	Metal	Lead	--	--	3/3	1.12E+04	1.55E+02	IR04B015	1.25	1.25	3,170
											IR04B028	1.25	1.25	4,180
											IR04B047	1.25	1.25	11,200
				PAH	Benzo(a)pyrene	1.84E-06	--	1/3	2.40E-01	3.30E-01	No samples exceed remediation goals			
				Pest/PCB	Aroclor-1260	1.88E-05	3.53E+00	3/3	1.40E+01	7.40E-01	IR04B015	1.25	1.25	14
											IR04B028	1.25	1.25	3.7
											IR04B047	1.25	1.25	2.6
AK31	3E-05	7E+00	6E+00	Metal	Lead	--	--	4/4	8.56E+03	1.55E+02	IR04B004	1.75	1.75	307
											IR04B017	1.75	1.75	9,000
											IR04B025	1.75	1.75	2,410
											IR04MW13A	1.75	1.75	4,920
				Pest/PCB	Aroclor-1260	3.37E-05	<1	4/4	2.50E+01	7.40E-01	IR04B017	1.75	1.75	2.8
											IR04B025	1.75	1.75	0.98
											IR04MW13A	1.75	1.75	25
AK32	5E-05	9E+00	9E+00	Metal	Lead	--	--	2/2	1.50E+03	1.55E+02	No samples exceed remediation goals			
				PAH	Benzo(a)pyrene	1.76E-06	--	2/2	2.30E-01	3.30E-01	No samples exceed remediation goals			
				Pest/PCB	Aroclor-1260	4.98E-05	9.33E+00	2/2	3.70E+01	7.40E-01	No samples exceed remediation goals			
					Dieldrin	2.13E-06	<1	1/2	2.50E-01	1.20E-01	No samples exceed remediation goals			
AK34	6E-05	5E+00	4E+00	Metal	Arsenic	3.41E-05	<1	3/3	1.27E+01	1.11E+01	No samples exceed remediation goals			
					Lead	--	--	3/3	1.82E+02	1.55E+02	No samples exceed remediation goals			
				Pest/PCB	Aroclor-1260	2.36E-05	<1	3/3	1.75E+01	7.40E-01	No samples exceed remediation goals			
AK36	1E-05	2E+00	<1	Metal	Lead	--	--	1/1	4.50E+02	1.55E+02	IR02B434	0.8	1.8	450
				PAH	Benzo(a)pyrene	4.44E-06	--	1/1	5.80E-01	3.30E-01	IR02B434	0.8	1.8	0.58
				Pest/PCB	Aroclor-1260	5.25E-06	<1	2/2	3.90E+00	7.40E-01	GRID 153 SIDEWALL	1.5	2	3.9
											IR02B434	0.8	1.8	2
AK37	3E-05	2E+00	2E+00	Metal	Lead	--	--	1/1	5.00E+02	1.55E+02	GRID 139 SIDEWALL	0	1	500
				PAH	Benzo(a)pyrene	9.19E-06	--	1/1	1.20E+00	3.30E-01	GRID 139 SIDEWALL	0	1	1.2
					Benzo(k)fluoranthene	1.53E-06	--	1/1	2.00E+00	1.30E+00	GRID 139 SIDEWALL	0	1	2

Table 7-16. Risk and Hazard Drivers and Associated Sampling Locations Exceeding Remediation Goals for Recreational Receptor Scenario, Surface Soil (0 to 2 feet bgs) *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Grid Number	RME Cancer Risk	RME HI	RME Segregated HI	Chemicals of Concern		Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Significant Sampling Information: Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
AK37 *(cont.)*	3E-05	2E+00	2E+00	Pest/PCB	Aroclor-1248	5.12E-06	<1	1/1	3.80E+00	7.40E-01	GRID 139 SIDEWALL	0	1	3.8
					Aroclor-1254	2.02E-06	<1	1/1	1.50E+00	7.40E-01	GRID 139 SIDEWALL	0	1	1.5
					Aroclor-1260	4.85E-06	<1	1/1	3.60E+00	7.40E-01	GRID 139 SIDEWALL	0	1	3.6
AL33	1E-05	<1	<1	Metal	Lead	--	--	3/3	2.27E+02	1.55E+02	IR12SS19	0	0	227
				PAH	Benzo(a)pyrene	4.67E-06	--	2/3	6.10E-01	3.30E-01	IR12SS19	0	0	0.61
				Pest/PCB	Aroclor-1260	2.56E-06	<1	2/3	1.90E+00	7.40E-01	IR12SS19	0	0	1.9
AL34	2E-05	<1	<1	Metal	Lead	--	--	3/3	1.60E+02	1.55E+02	No samples exceed remediation goals			
				PAH	Benzo(a)pyrene	8.42E-06	--	3/3	1.10E+00	3.30E-01	IR02TA11A	1.56	1.56	0.72
					Benzo(b)fluoranthene	2.07E-06	--	3/3	2.70E+00	1.30E+00	IR02TA11A	1.56	1.56	2.7
				Pest/PCB	Aroclor-1260	1.88E-06	<1	3/3	1.40E+00	7.40E-01	IR02TA11A	1.56	1.56	1.3
											IR12B038	0	2	1.3
AL36	4E-06	<1	<1	Pest/PCB	Aroclor-1260	3.50E-06	<1	1/1	2.60E+00	7.40E-01	No samples exceed remediation goals			

Notes:

a Total PCBs (non-dioxin) were identified as a chemical of concern. Congener-specific PCB results associated with total PCBs (non-dioxin) are shown.

<1 Less than 1
-- Not applicable
bgs Below ground surface
EPC Exposure point concentration
HI Hazard index
mg/kg Milligram per kilogram
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
Pest Pesticide
RME Reasonable maximum exposure

Table 7-17 Summary Statistics for Parcel E-2 Onshore SLERA
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Chemical	HPAL (mg/kg)	PSC (mg/kg)	Maximum Soil Concentrations (mg/kg)			Number of Samples Exceeding PSC		
			Landfill Area	Panhandle Area	East Adjacent Area	Landfill Area	Panhandle Area	East Adjacent Area
Beryllium	0.71	135	1.4	1.18	1.1	0	0	0
Cadmium	3.14	4	12	37	11.82	2	13	6
Chromium VI	SS	669	0.06	10	1.5	0	0	0
Copper	124.3	470	2,300	27,000	7,700	7	20	35
Lead	8.99	197	9,700	9,300	11,215.9	12	32	38
Manganese	1,431.2	2,400	1,547.58	12,000	2,400	0	6	0
Mercury	2.28	1	7.4	190	46.67	10	10	31
Nickel	SS	1,941	982	1,600	2,000	0	0	1
Selenium	1.95	10	3.4	6.4	6.2	0	0	0
Silver	1.43	15	1	11	1.51	0	0	0
Thallium	0.81	88	0.6	7.2	6.9	0	0	0
Vanadium	117.2	117	410	2,100	520	2	11	3
Zinc	109.9	719	4,100	7,100	4,104.96	7	23	28
Dieldrin	NA	18	0.71	6.4	2.7	0	0	0
Methoxychlor	NA	509	0.36	4.2	3.3	0	0	0
Total DDT	NA	4	0.77	0.087	5.8	0	0	4
Total Aroclors	NA	37	380	20	640	3	0	10
HMW PAHs	NA	231	29.45	382.3	35	0	1	0
LMW PAHs	NA	10,056	8.33	50.6	5.4	0	0	0

Table 7-17 Summary Statistics for Parcel E-2 Onshore SLERA *(continued)*
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

Chemical	HPAL (mg/kg)	PSC (mg/kg)	Maximum Soil Concentrations (mg/kg)			Number of Samples Exceeding PSC		
			Landfill Area	Panhandle Area	East Adjacent Area	Landfill Area	Panhandle Area	East Adjacent Area
Toluene	NA	4,577	0.019	0.019	0.12	0	0	0
Trichloroethene	NA	123	ND	ND	0.013	0	0	0
Xylene (total)	NA	369	0.004	ND	0.056	0	0	0

Notes:

DDT	dichlorodiphenyltrichloroethane
HMW	high-molecular-weight
HPAL	Hunters Point ambient level
LMW	low-molecular-weight
mg/kg	milligram per kilogram
NA	not applicable
ND	nondetected
PAH	polycyclic aromatic hydrocarbon
PSC	protective soil concentration
SLERA	screening-level ecological risk assessment
SS	soil specific

Table 7-18. Groundwater COPECs for Aquatic Wildlife
Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard

		Screening Evaluation		Trigger Level Evaluation (for Inland Areas > 250 feet from shoreline)		
Chemical Group	COPEC	Aquatic Evaluation Criterion (µg/L)[a]	Nearshore Wells Recommended for Further Monitoring and Evaluation [b],[c]	Attenuation Factor Selected for Inland Area[d]	Calculated Trigger Level (µg/L)[e]	Inland Areas (Where Trigger Levels are Exceeded) Recommended for Further Monitoring and Evaluation [c],[f]
Anions	Un-ionized Ammonia	25	IR01MW38A, IR01MW48A, IR01MW47B, IR01MW43A[g], TW053, TW023, TW024, TW002, TW045, TW003, TW013, TW014, TW016, TW032, TW031, TW040, TW039, and PZ150D	1	25	TW001, TW007, TW009, TW010, TW011, TW025, TW049, and TW055
	Cyanide	1	IR01MW38A, IR01MW48A, IR01MW60A, IR01MW62A, and IR01MW63A	NA	NA	NA
	Sulfide	2[h],[i]	IR01MW43A[g], IR01MW48A, IR01MW53B, IR01MW60A, IR01MW64A, and IR01MWI-3	NA	NA	NA
Metals	Copper	28[j]	IR01MW53B, TW018, TW019, TW020, and TW045	2	56	TW004, TW005, and PZ131F
	Lead	14.4[j]	IR01MW43A[g], TW021, TW028B, and TW029	NA	NA	NA
	Zinc	81	IR01MW43A[g], IR01MW44A, TW020, TW021, TW029, and TW006	NA	NA	NA
Pesticides and PCBs	PCBs (Total)	0.03[i]	IR01MW43A[g], IR01MW44A,TW036, TW038, TW047, TW021, TW031, TW040, TW039, and PZ150D	2	0.06	TW005 and PZ131F
Petroleum Hydrocarbons	TPH (Total)	1,400 - 20,000[k]	IR01MWI-3[g], IR01MW43A[g], TW033, TW032, TW031, PZ150E, TW016, TW013, TW042, and TW041	NA	NA	NA

Notes:
(a) References for the aquatic evaluation criteria are included in Appendix M.
(b) Nearshore wells are located within 250 feet of the Parcel E-2 shoreline. Most nearshore wells are located within the tidally influenced zone (where the maximum tidal fluctuation exceeds 0.10 foot in the A-aquifer based on data collected during the Phase III groundwater data gaps investigation [TtEMI, 2004a]).
(c) Temporary wells (denoted by the prefix TW in the table above) were installed as part of a data gaps investigation and are not available for long-term monitoring; however, they were included in this table to guide well placement during the development of the groundwater remedial action monitoring plan.
(d) Attenuation factor assigned based on nomographs developed specifically for HPS groundwater (see Appendix M, Attachment M-1).
(e) Value calculated by multiplying the aquatic evaluation criterion by the attenuation factor.
(f) Inland monitoring wells are located more than 250 feet inland from the Parcel E-2 shoreline.
(g) Wells IR01MWI-3 and IR01MW43A were decommissioned prior to the PCB Hot Spot Area removal action; these wells were replaced with IR01MW60A and IR01MW64A, respectively.
(h) Criterion shown applies to hydrogen sulfide, not total sulfide
(i) Criterion is significantly lower (at least 10 times less) than reporting limit for current, routinely used analytical methods
(j) Value shown has been HGAL-adjusted and is applicable to the A-aquifer.
(k) Range of values shown; total TPH aquatic criteria assigned as a function of distance from shoreline; the source of these criteria is the "Final New Preliminary Screening Criteria and Petroleum Program Strategy, Hunters Point Shipyard, San Francisco, California" (Shaw Environmental, Inc., 2007)

µg/L micrograms per liter
COEPCs chemicals of potential ecological concern
NA not applicable
PCBs polychlorinated biphenyls
TPH total petroleum hydrocarbons

Section 8. Remedial Investigation Summary and Conclusions

According to EPA guidance and the NCP (40 CFR § 300.430), the goal of an RI/FS is to provide the information necessary to (1) adequately characterize the site, (2) define site dynamics (by developing a conceptual site model), (3) define risks, and (4) develop and evaluate appropriate remedial alternatives (EPA, 1991a). The information contained in Sections 1 through 7 of this report satisfy the first three goals, and the FS presented in the forthcoming sections will satisfy the fourth goal by developing prospective remedies for Parcel E-2. As discussed in Section 1.1.4, this RI/FS Report addresses CERCLA hazardous substances except for radionuclides. Radionuclides in soil and groundwater are evaluated in the radiological addendum to this RI/FS Report.

Section 8.1 presents an overview of the RI approach used to satisfy the first three goals. Sections 8.2 through 8.7 summarize the RI findings for each of the media affected by site contamination:

- Solid waste and soil in the Landfill Area (Section 8.2)
- Landfill gas (Section 8.3)
- Soil and isolated solid waste in the Panhandle and East Adjacent Areas (Section 8.4)
- Groundwater (Section 8.5)
- Surface water (Section 8.6)
- Shoreline sediment (Section 8.7)

Section 8.8 summarizes the affected media for which remedial option analysis in the FS is required.

8.1. REMEDIAL INVESTIGATION APPROACH

The Navy's overall approach in achieving the first three goals of the RI/FS process is summarized in the following subsections.

8.1.1. Site Characterization

The RI evaluated characterization data collected during the past investigations, removal actions, and monitoring programs. Soil, sediment, soil gas, and groundwater data used in these evaluations were obtained from RI field activities (1988 to 1996), subsequent data gaps investigations (2000 to 2003 and 2007 to 2008), and ongoing monitoring programs (2003 to present). This data set is quite substantial, containing over 1,800 soil and groundwater samples analyzed for various chemicals. The data were initially evaluated to identify chemicals whose presence might be attributed to past Navy site operations. The evaluation was then focused by comparing the site data against risk-based regulatory criteria. Drawing from available risk-based criteria, a set of site-specific evaluation criteria (referred to as RIECs) were selected which take into account reasonably anticipated reuse and exposure pathways. The RIECs were selected to be adequately conservative to depict the extent of chemicals that may pose a risk to human health or the environment. The processes for selecting soil and groundwater RIECs were discussed in Sections 4.1.3.2 and 5.6, respectively. Finally, potential data gaps were identified, and an assessment was made of the uncertainty resulting from these data gaps.

The site characterization data were presented and evaluated in the following portions of this document:

- The physical characteristics of Parcel E-2, including geology, hydrogeology, hydrology, and ecology, were discussed in Section 2. This information was derived from numerous soil, sediment, and groundwater investigations and several specialized studies, including aquifer tests, tidal influence studies, and ecological assessments.
- A chronology and summary of past investigations, interim actions, and monitoring programs was presented in Section 3.
- The nature and extent of solid waste, landfill gas, and chemicals in soil within the three onshore study areas (the Landfill Area, Panhandle Area, and East Adjacent Area) were discussed in Section 4, and are summarized briefly in Sections 8.2, 8.3, and 8.4.
- The nature of extent of chemicals in groundwater was discussed in Section 5, and is summarized briefly in Section 8.5.
- The nature and extent of chemicals in sediments within the Shoreline Area were defined during the SDGI, and this assessment was presented in the Shoreline Characterization Technical Memorandum (see Appendix G to this RI/FS Report).
- Characterization information for outdoor air and surface water runoff was presented in Sections 3.7 and 3.9.3, respectively.

It should be noted that an evaluation of the nature and extent of radioactive chemicals at Parcel E-2 is not presented in this RI/FS Report. A brief summary of radiological investigations performed at Parcel E-2 (from 1988 to 2002) was provided in Section 3.6. The most recent radiological investigation at Parcel E-2 was completed in conjunction with the 2008 groundwater investigation along the Parcel E-2 shoreline. The results of that investigation are summarized in the radiological addendum to this RI/FS Report.

8.1.2. Conceptual Site Model

The conceptual site model is an understanding of the dynamics of the site's environmental concerns, and serves as the basis for the development of the RAOs. The conceptual site model is used to understand potential sources of contamination, migration pathways, and human and ecological receptors that the

RAOs are intended to address. The conceptual site model was developed by incorporating site-specific landfill characteristics into EPA's generic site conceptual model for municipal landfills (EPA, 1991a).

The primary potential source of contamination at Parcel E-2 is solid waste in the Landfill Area. The landfill solid waste is defined by the physical presence of contiguous industrial or municipal-type wastes; however, the landfill solid waste also includes construction debris and soil fill. Another primary potential source of contamination is the industrial waste disposed of in the Panhandle and East Adjacent Areas. Potentially affected media at Parcel E-2 consist of soil, subsurface air (emanating from the landfill), outdoor air, groundwater, surface water runoff, intertidal sediment, and wetlands (tidal and freshwater). As shown in the table below, exposure pathways, exposure points, and potential receptors were identified for each contaminated medium (soil, subsurface air, groundwater, surface water, sediments, and wetlands).

Affected Media	Exposure Point	Exposure Route	Primary Receptor
Soil	On Site	Dermal Contact	Future Site Users and Site Workers
		Ingestion	Terrestrial Wildlife
Subsurface Air	Off Site	Inhalation, Explosion	Residents and Area Workers
	On Site	Inhalation, Explosion	Site Workers and Future Site Users
Groundwater	Off Site (via B-aquifer wells)	Ingestion, Dermal Contact, Inhalation	People with Residential and Commercial Wells
Surface Water and Sediments (including effects from A-aquifer groundwater)	Off Site	Ingestion, Bioconcentration	Aquatic Wildlife and People Swimming
	On Site	Ingestion, Dermal Contact	Trespassers and Future Site Workers
Wetlands (including effects from A-aquifer groundwater)	On Site	Ingestion	Wildlife in Wetland Ecosystem

Outdoor air (referred to as air/dust on Figure 6-3) does not present a primary exposure pathway because, as discussed in Section 6.2.3, dust mitigation and removal actions are adequately controlling airborne dust contamination. However, the HHRA conservatively considers potential exposure to contaminated soil that may migrate to outdoor air through wind suspension and volatilization.

8.1.3. Site Risks

Potential risks to human and ecological receptors were evaluated for each of the contaminated media identified above. The risk evaluations performed for each medium are listed below, and are discussed in Sections 8.2 through 8.7.

Human Receptors

- A quantitative HHRA was performed for soil within the Landfill, Panhandle, and East Adjacent Areas. The results were presented in Section 7.1, and are summarized briefly in Sections 8.2 and 8.4.
- Risks to human health from NMOCs in landfill gas were evaluated using the Johnson and Ettinger vapor intrusion model (EPA, 2003a), and resulted in the development of an NMOC action level of 500 ppmv. These activities were discussed in Section 4.1.2.2, and are summarized briefly in Section 8.3.3.
- A quantitative HHRA was performed for groundwater throughout Parcel E-2. The results were presented in Section 7.1, and are summarized briefly in Section 8.5.

Ecological Receptors

- An onshore SLERA was performed for soil within the Landfill, Panhandle, and East Adjacent Areas. The results were presented in Section 7.2 and Appendix L, and are summarized briefly in Sections 8.2 and 8.4.
- An offshore SLERA was performed for intertidal sediment within the Shoreline Area. The results were presented in Section 7.2 and Appendix G, and are summarized briefly in Section 8.7.
- A screening-level evaluation of ecological risk to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2 is provided in Appendix M, and is summarized briefly in Section 8.5. Chemical concentrations in groundwater were screened against the assigned aquatic evaluation criteria, mainly comprised of saltwater aquatic criteria, to identify COPECs for surface water quality. Site-specific data for select COPECs were then evaluated against trigger levels, consistent with the methods used in recent FS reports at other HPS parcels, to confirm if the COPECs posed a potential risk to aquatic receptors requiring remedial option analysis.
- Potential exposure of ecological receptors to unacceptable chemical concentrations in surface water runoff is monitored in accordance with a SWDMP (MARRS and MACTEC, 2009b). The results of the Parcel E-2 stormwater program were discussed in Section 3.9.3, and are summarized briefly in Section 8.6.
- Potential risks to ecological receptors from exposure to wetlands soil and sediment were evaluated in conjunction with the offshore and onshore SLERAs (Appendices G and L, respectively). However, very little soil and sediment data have been collected because of the limited investigation activities conducted within wetland areas given their saturated conditions that make subsurface drilling activities difficult. In the absence of such data, it is assumed that soil and sediment conditions in the wetland areas are similar to the adjoining areas.

8.2. SOLID WASTE AND SOIL IN THE LANDFILL AREA

The following subsections summarize the nature and extent of solid waste and chemicals in soil within the Landfill Area of Parcel E-2 (Section 8.2.1), the results of the risk assessments (Section 8.2.2), and the overall conclusions for the Landfill Area (Section 8.2.3).

8.2.1. Nature and Extent of Solid Waste and Chemicals in Soil

The nature and extent of contamination at the Parcel E-2 Landfill was evaluated based on information from the previous investigations and removal actions described in Section 3. The EPA's presumptive remedy guidance states that "characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these sites except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate" (EPA, 1993a). EPA guidance provides a framework for determining whether the containment presumptive remedy applies to a specific military landfill (EPA, 1996). The first step is to evaluate the available information to determine the sources, types, and volumes of landfill wastes. The following subsections outline the available information for the Parcel E-2 Landfill to support this evaluation. The remaining steps in the decision framework are discussed in Section 8.2.3.

8.2.1.1. Waste Types Encountered During Field Activities

Based on data from 28 soil borings, 18 monitoring wells, and 25 test pits extended within the Landfill Area (Figures 3-1 and 3-2), the contiguous solid waste is composed primarily of municipal-type waste and construction debris. The solid waste includes wood, paper, plastic, metal, glass, asphalt, concrete, and bricks that are mixed with sand, clay, and gravel fill. Construction debris (such as asphalt, concrete, and brick) is typically inert. Inert waste does not contain significant quantities of putrescible (i.e., decomposable) waste, and is not expected to generate leachate that would create potential risks to human health or the environment. The presence of construction debris, although typically considered an inert waste, was evaluated in conjunction with municipal-type waste because certain types of construction debris (most notably wood) and most municipal-type wastes readily biodegrade and may be considered putrescible.

In addition to municipal-type waste and construction debris, historic information indicates that industrial wastes were also disposed of in or around the Landfill Area, including sandblast waste, radioluminescent devices, asbestos-containing debris, paint sludge, solvents, and waste oils (NEESA, 1984; NAVSEA, 2004). The presence of some of these industrial wastes has been confirmed during the removal action at the PCB Hot Spot Area, which extends into a small portion the Landfill Area (Figure 1-3). Small quantities of LLRW from the disposal of radioluminescent devices and potentially radioactive sandblast waste have been encountered during implementation of the removal actions at the PCB Hot Spot Area (Navy, 2005b through 2005f; TtECI, 2007a). Out of a total excavated volume of

44,500 cubic yards, 533 cubic yards of soil and fire brick (1.2% by volume) was segregated as radiologically impacted. Also, 40 radiological devices, 78 cubic yards of metal debris, and 19 pieces of other radioactively contaminated debris were identified within the removal area (TtECI, 2007a). In addition, 41 pieces of MPPEH were encountered in the excavation area, consisting primarily of expended cartridge casings of various calibers and protective caps, but also included an empty 5-inch practice projectile and a 3-pound practice bomb (TtECI, 2010). Of the 41 MPPEH items discovered in the removal area, 20 items were verified to not present an explosive hazard and were reclassified as MDAS. The remaining 21 MPPEH items appeared to have been subject to previous demilitarization actions and could not be completely inspected by UXO technicians for possible explosive hazards. Although the type, age, and condition of these 21 MPPEH items did not suggest a high potential for residual energetic material, the Navy, as a precautionary measure, properly handled, transported, and disposed of these items as either material documented as an explosive hazard (MDEH) (20 items consisting of expended cartridge casings of various calibers) or munitions and explosives of concern (MEC) (1 item. 3-pound practice bomb) (TtECI, 2010). The characterization data suggest that the quantity of industrial waste within the Landfill Area is less than the quantity of municipal-type waste and construction debris.

Additional information on subsurface conditions in the Landfill Area was obtained during installation of the sheet-pile wall in the southeast portion of Parcel E-2 (Figure 1-3). In September 1997, an obstruction was encountered at a depth of approximately 20 feet bgs, accompanied by a release of pressurized gas to the surface. The atmosphere in this area was monitored for health and safety purposes, specifically for explosive conditions (using an LEL meter) and various compounds, including natural gas, chlorine, and hydrogen sulfide (using colorimetric indicator tubes). Sporadic detections of atmospheric conditions above 10 percent of the LEL and chlorine gas above 5 ppm were encountered during health and safety monitoring. Approximately 80 feet of the sheet-pile wall (as originally designed) was realigned to avoid the subsurface obstructions. The alternate alignment consisted of an approximate 50-foot-long section that was off-set approximately 20 feet from the design alignment, with the remaining portion gradually angling back to the design alignment. The remainder of the sheet-pile wall was completed with no additional releases of subsurface gas (IT, 1999). These subsurface conditions may be indicative of solid waste at this location, and the sporadic detections of chlorine gas are a health and safety concern because they are above the permissible exposure limit (established by the Occupational Health and Safety Administration) of 1 ppm. However, no definitive conclusions on the nature of the potential waste at this depth can be drawn from the observed conditions.

8.2.1.2. Operating History

Overall, the operating history of the Parcel E-2 Landfill is not well documented (TtEMI, LFR, and U&A, 1997). The following items summarize the available historic information:

- The IAS indicated that, between 1958 and 1974, the Navy created the Parcel E-2 Landfill by placement of a variety of shipyard wastes, including construction debris, municipal-type solid waste, and industrial waste (including sandblast waste, paint sludge, solvents, and waste oils) (NEESA, 1984).
- The HRA indicated that the Parcel E-2 Landfill, along with other areas within Parcels E and E-2, was a disposal area for radioluminescent devices (primarily containing radium-226), and that the landfill was a potential disposal area for wastes from decontamination of ships used in atomic testing (NAVSEA, 2004)
- An oily waste area was identified on Navy drawings along the western perimeter of the Landfill Area (Navy, 1974). During preliminary closure activities in 1974, ponded liquid was removed and the top 6 inches of soil at the oily waste area was scarified before the soil cover was placed. Based on borings and exploratory trenches, this area also was partially filled with solid waste during closure; therefore, this area is included within the boundaries of solid waste at the Parcel E-2 Landfill (TtEMI, 2004f).
- Triple A allegedly disposed of industrial debris, sandblast waste, oily industrial sand, and asphalt over an area of approximately 5 acres along the shoreline of Parcel E-2. In addition, Triple A allegedly stored unlabeled, deteriorating, uncovered drums with their contents exposed to the elements in the southeast corner of Parcel E-2 (Figure 1-11; SFDA, 1986).
- Waste fuel and waste oil containing PCBs were used at the Parcel E-2 Landfill as dust suppressants (TtEMI, LFR, and U&A, 1997).

8.2.1.3. Nature and Extent of Chemicals in Soil

The soil data set within the Landfill Area was derived from 333 soil samples (26 soil borings, 27 excavation grids within the PCB Hot Spot Area, 12 monitoring wells, and 25 test pits) collected from the intermittent soil fill mixed within the solid waste. As discussed in Section 4.2.4, soil characterization data are used to assess the approximate lateral and vertical extent (relative to the landfill waste volume) of hazardous substances above the RIECs, and to provide a basis for determining whether lesser quantities of hazardous wastes are present in the landfill as compared with municipal wastes. In addition, the characterization data are used to identify potential hot spots (defined as locations containing chemical concentrations 100 times greater than the corresponding RIEC) within the Landfill Area and, based on criteria established by EPA, to determine whether these hot spots require more extensive characterization and development of remedial alternatives.

Metals, pesticides, PCBs, SVOCs, VOCs, and petroleum hydrocarbons were detected at concentrations exceeding the RIEC in soil samples collected at the Landfill Area. These exceedances are summarized below.

- Eight metals (antimony, arsenic, cadmium, chromium, copper, iron, lead, and vanadium) were detected at concentrations exceeding the RIECs at depths greater than 2 feet bgs. Only lead exceeded the RIEC at samples collected from 0 to 2 feet bgs. None of these exceedances were indicative of hot spots.

- Total high risk PCBs (consisting of all Aroclor compounds except Aroclor-1016) were detected at concentrations exceeding the RIEC in more than 30 percent of the samples collected within each depth range evaluated (0 to 2 feet bgs, 2 to 10 feet bgs, and greater than 10 feet bgs). Most of these exceedances were not indicative of hot spots; however, several samples contained PCBs at concentrations that were greater than 100 times the RIEC (0.74 mg/kg) and may be considered potential hot spots within the landfill (described further below).

- SVOCs were detected at concentrations exceeding RIECs throughout the Landfill Area. The frequency of SVOC exceedances is highest in the 2- to 10-feet-bgs range. Benzo(a)pyrene, 1,4-DCB, and naphthalene were the most prevalent SVOC exceedances in the Landfill Area. Most of these SVOC exceedances were not indicative of hot spots, with two exceptions (described further below).
- VOCs were detected at concentrations exceeding RIECs at depths greater than 10 feet bgs in the Landfill Area.
- Total TPH (TPH-g, TPH-d, and TPH-mo combined) was detected at concentrations exceeding the TPH source criterion (3,500 mg/kg) at depths greater than 2 feet bgs in the Landfill Area.

Based on the data presented in Table 4-24, soil contamination is less extensive within Landfill Area soil at depths of 0 to 2 feet bgs; only two chemicals (total high risk PCBs and benzo(a)pyrene) exceeded the RIEC in more than 10 percent of samples analyzed. This conclusion is attributed to the fact that the upper 2 feet of soil in the Landfill Area comprises relatively clean fill that was placed during closure activities in 1974. Residual contamination in this interval can be attributed to surface releases after 1974.

Based on the information presented in Section 4.2.4, nearly all of the chemicals detected in Landfill Area soil at concentrations above RIECs were of a limited extent relative to the overall waste volume. Several chemicals, such as SVOCs and PCBs, such as benzo(a)pyrene and total high risk PCBs, were detected in soil throughout the Landfill Area at concentrations above RIECs, but were not indicative of hot spots. These results demonstrate that lesser quantities of potentially hazardous industrial wastes are present in the landfill as compared with municipal-type waste and construction debris.

Based on the information presented in Section 4.2.4, which presents chemical results from the intermittent soil fill mixed within the solid waste, the following potential hot spots were identified at the Landfill Area:

- Edges of PCB Hot Spot Area excavation in southern portion of Landfill Area (0 to 10 feet bgs): Three samples contained total high risk PCBs at concentrations greater than 100 times the RIEC (0.74 mg/kg).
- Northern and central portions of Landfill Area (2 to 10 feet bgs): One sample (IR01MW05A, 8 feet bgs) contained total high risk PCBs at a concentration greater than 100 times the RIEC (0.74 mg/kg). In addition, one sample (IR01MW02B, 9 feet bgs) contained 1,4-DCB at a concentration greater than 100 times the RIEC (0.13 mg/kg). Also, one sample (IR01B021A, 9 feet bgs) contained naphthalene at a concentration greater than 100 times the RIEC (1.5 mg/kg). These locations are over 300 feet apart.
- Northern and central portions of Landfill Area (greater than 10 feet bgs): Three samples (IR01MW17B, 11 feet bgs; IR01B012, 17 feet bgs; IR01B019, 16 feet bgs) contained total high risk PCBs at concentrations greater than 100 times the RIEC (0.74 mg/kg). These locations are more than 400 apart from each other.

The portions of the PCB Hot Spot Area that extend into the Landfill Area remain a known contaminant source. Although the removal action (2006–2007) addressed the majority of this area, the shoreline portion of the PCB Hot Spot Area was not excavated because of its proximity to San Francisco Bay (see Figure 1-3). Therefore, this area should be further evaluated in the FS portions of this report based on several factors: (1) post-excavation soil samples with PCB concentrations greater than 100 times the RIEC; (2) the proximity of this area to San Francisco Bay; and (3) the elevated PCB concentrations in groundwater reported in this immediate area during previous monitoring and the 2008 data gaps investigation. The evaluation recommended for the FS should also include the area to the northwest of the PCB Hot Spot Area, along the shoreline in a wetland area, which was initially planned to be excavated during the PCB Hot Spot Area TCRA. This area was not included in the removal action based on field conditions and accessibility.

The Navy initiated a follow-on removal action to address contaminated soil adjacent to the excavation boundary of the TCRA at the 2007 PCB Hot Spot Area (Navy, 2010). This follow-on removal action was initiated in March 2010 and is projected to be completed in 2011; however, because the results of the follow-on removal action were not available for inclusion in this RI/FS Report, the remedial alternatives in this FS evaluate these areas.

The potential PCB hot spots within the northern and central portions of the Landfill Area were localized relative to the overall waste volume and were relatively deep (8 to 17 feet bgs). In addition, these potential PCB hot spots do not appear to have migrated to groundwater within the landfill. During groundwater sampling performed since 2001 at the 10 monitoring wells either collocated or in close proximity to these potential soil hot spots (Figure 5-29), PCB concentrations in groundwater were either not detected above laboratory reporting limits or detected sporadically (at well IR01MW38A in 1 out of 17 events since August 2002; at well IR01MW05A in 3 out of 11 events since August 2002). Finally, these potential PCB hot spots are located 390 to 780 feet from the Parcel E-2 shoreline and, based on data presented on Figures 4-23, 4-43, and 5-29, show no connection with the PCB Hot Spot Area that was remediated in the East Adjacent Area.

The potential 1,4-DCB and naphthalene hot spots within the northern and central portions of the Landfill Area were localized relative to the overall waste volume and were relatively deep (9 feet bgs). In addition, these potential hot spots do not appear to have significantly affected groundwater concentrations in the immediate vicinity. During groundwater sampling performed since 2001 at well IR01MW03A (adjacent to well IR01MW02B), 1,4-DCB was detected in groundwater during 9 of 16 events (at concentrations ranging from 0.15 to 2.8 µg/L; below the state MCL of 5 µg/L). During groundwater sampling performed since 2001 at wells IR01MWI-5 and IR01MW366A (the wells closest to IR01B021A), naphthalene was detected in groundwater during 1 of 11 events (at a concentration of

1.8 µg/L; below the state drinking water action level of 17 µg/L). Groundwater analytical results for these wells are presented in Appendix J1.

8.2.1.4. Lateral and Vertical Extent of Solid Waste

Determination of the extent of solid waste at the Parcel E-2 Landfill is based on the physical presence of contiguous industrial or municipal-type wastes. Overall, the lateral and vertical extent of solid waste at the Parcel E-2 Landfill has been adequately defined by the soil borings and test pits installed within, and adjacent to, the Landfill Area.

The lateral extent of waste at the Landfill Area is shown on Figure 3-1. The northern extent of waste was determined to be along the fence line separating Parcel E-2 from the UCSF compound (along the gas control system barrier wall). The eastern edge of the solid waste is located beneath the interim landfill cap. The southeastern edge of solid waste is located adjacent to the shoreline, and the southwestern edge is located adjacent to the freshwater wetlands within the Panhandle Area. The western edge of solid waste is located adjacent to the drainage channel along the western property boundary.

The waste interval is generally located between 21 feet above and 14 feet below msl, and varies from approximately 10 to 25 feet thick. In most areas of the Parcel E-2 Landfill, waste is in direct contact with groundwater. The northwest corner of the landfill is the only area where waste is not in direct contact with groundwater.

8.2.1.5. Size and Volume

The physical extent of solid waste covers approximately 22 acres (TtEMI, 2004f). Based on a review of the geologic cross sections presented in Section 2, waste across the Landfill Area varies from less than 10 feet thick to greater than 25 feet thick (with an average thickness of about 13 feet). The estimated volume of solid waste in the Landfill Area is approximately 473,000 cubic yards (including soil fill contained within the solid waste, but excluding the overlying soil cover).

8.2.2. Risk Assessments for Landfill Area

The following subsections present the results of the HHRA and SLERA performed on soil data within the Landfill Area.

8.2.2.1. Human Health Risk Assessment

Although use of the landfill presumptive remedy typically allows for qualitative risk evaluations instead of more detailed quantitative evaluations, a quantitative HHRA was performed because the Panhandle and East Adjacent Areas do not meet the criteria for application of the containment presumptive remedy. The results of the HHRA helped determine whether risks attributed to the waste within the Landfill Area are "low-level" and therefore consistent with EPA's definition of municipal-type waste suitable for application of the containment presumption.

Methodology

The HHRA calculated cancer risks and noncancer hazards from exposure to COPCs in soil for adult and child recreational users and adult construction workers. Half-acre exposure grids were used to evaluate recreational and construction worker exposures. The evaluation of risks from exposure to soil at Parcel E-2 includes both a total risk assessment and an incremental risk assessment. The total risk evaluation estimated the risks posed by chemicals at the site, including those present at concentrations at or below ambient levels. The incremental risk evaluation also provides an estimate of the risks posed by chemicals at the site, but does not include the risks for those chemicals present at or below ambient levels. Preparation of the incremental HHRA is required by Navy policy (Navy, 2004).

The HHRA did not include radioactive chemicals as COPCs because, as discussed in Section 8.1.1, potential risks associated with human exposure to radioactive chemicals at Parcel E-2 are summarized in the radiological addendum to this RI/FS Report.

Results

For the recreational exposure scenario (Figure 7-2), the results of the incremental risk evaluation indicated that the COCs were several SVOCs (primarily benzo[a]pyrene) and PCBs. Of the 60 exposure grid cells located either completely or partially within the Landfill Area, 18 grid cells had EPCs (for soil from 0 to 2 feet bgs) resulting in risk above one or more of the risk thresholds (1×10^{-6} for cancer risk; segregated HI of 1 for noncancer risk; and 155 mg/kg for lead exposure). Of the remaining 42 grid cells, 11 grid cells did not exceed any risk thresholds and 31 grid cells contained no data on which risk calculations could be based. For grid cells with risk above one or more of the risk thresholds (Table 7-3), cancer risks ranged from 3×10^{-6} to 3×10^{-5} and total noncancer HIs were less than 1. The cited ranges exclude the risk from grid cell AD33 (total cancer risk of 2×10^{-4} and a total noncancer HI of 4) because all data within this grid cell were located in the Panhandle Area. The cited ranges also exclude the risk from grid cells AH34, AI34, and AI35 (total cancer risk from 2×10^{-5} to 9×10^{-5} and total noncancer HIs from 4 to 20) because data driving risk within these grid cells were from an area within the PCB Hot Spot Area excavation for which additional assessment is recommended in the FS portions of this report.

For the construction worker exposure scenario (Figure 7-4), the results of the incremental risk evaluation indicated that the COCs were antimony, arsenic, cadmium, copper, iron, lead, and vanadium; several SVOCs (primarily benzo[a]pyrene); and several PCBs (primarily Aroclor-1260). Of the 60 exposure grid cells located either completely or partially within the Landfill Area, 24 grid cells had EPCs (for soil from 0 to 10 feet bgs) resulting in risk above one or more of the risk thresholds. Of the remaining 36 grid cells, 16 grid cells did not exceed any risk thresholds and 20 grid cells contained no data on which risk calculations could be based. For grid cells with risk above one or more of the risk thresholds (Table 7-7), cancer risks ranged from 2×10^{-6} to 4×10^{-4} and total noncancer HIs ranged from less than 1 to 700.

Conclusions

Results of the HHRA demonstrate that risk for the reasonably anticipated reuse scenario (recreational exposure) is lower than for potential exposure of construction workers. This finding is expected because potential recreational user exposure is limited to soil at 0 to 2 feet bgs, which consists of soil cover overlying the solid waste, while potential construction worker exposure is from 0 to 10 feet bgs (or into the solid waste). The risk for the recreational exposure scenario is associated primarily with SVOC and PCB concentrations that were attributed to surface releases following closure of the landfill in 1974. Results of the HHRA also indicate that, for both the recreational user and construction worker exposure scenarios, cancer risks are within the acceptable risk range of 10^{-6} to 10^{-4} specified in the NCP (55 Federal Register 8848, March 8, 1990).

The data distribution within the Landfill Area is considered adequate to evaluate potential human health risks relative to the framework established in EPA guidance for CERCLA landfills (EPA, 1991a, 1993a, and 1996). The purpose of the quantitative HHRA was not necessarily to characterize risk within each exposure area (grid), but the HHRA was performed within the Landfill Area in this manner to be consistent with the HHRA in the adjacent areas (the Panhandle and East Adjacent Areas). Furthermore, performing this quantitative HHRA assists in confirming that risks attributed to waste within the Landfill Area are "low-level" and therefore consistent with EPA's definition of municipal-type waste suitable for application of the containment presumption. For grid cells with no data, it is reasonable to presume they might contain chemical concentrations that could result in risks of the same relative magnitude as found elsewhere in the Landfill Area.

8.2.2.2. Screening-Level Ecological Risk Assessment

To update the previous ecological assessments with recent data collected during the SDGI, the Navy implemented the following steps: (1) evaluated the new data set to validate the COPEC list used in the previous BERA for terrestrial receptors; (2) identified additional chemicals as COPECs and calculated PSCs for these additional chemicals; and (3) updated the previous ecological assessments by performing a SLERA for onshore receptors using the updated PSCs and surface soil data set. The onshore SLERA evaluated soil data within the Landfill, Panhandle, and East Adjacent Areas, including data collected within wetland areas (Appendix L).

Concentrations of cadmium, copper, lead, mercury, vanadium, zinc, and PCBs exceeded PSCs (adjusted by HPALs, as appropriate) and are considered a potential threat to birds and mammals exposed to soil in the Landfill Area. As shown on Figure 7-5, 12 out of 44 locations in the Landfill Area contained soil concentrations above the PSCs (adjusted by HPALs, as appropriate). The majority of these PSC exceedances were located with the portion of the PCB Hot Spot Area that extends into the Landfill Area. This finding is expected because potential risk at these locations was driven by samples collected either at 2 feet bgs (at the interface between the soil cover and underlying solid waste) or deeper than 2 feet bgs (into the solid waste). Similar to the HHRA conclusions, the data distribution within the Landfill Area is considered adequate to evaluate potential ecological risks, and areas with no data may contain chemical concentrations that would result in risks of the same relative magnitude as found elsewhere in the Landfill Area.

8.2.3. Conclusions for Solid Waste and Soil in Landfill Area

As discussed in Section 1.4, the EPA has developed a specialized RI/FS process for municipal landfill sites (EPA, 1991a, 1993a, 1993b, and 1994) that, provided that certain conditions are met, supports selection of a containment presumptive remedy. Use of the specialized process is intended to improve and accelerate the site characterization and remedy evaluation process and to ensure consistent evaluation of remedial actions at similar sites. Use of this specialized process is considered appropriate for the Landfill Area. Therefore, the following conclusions about the site characterization efforts (Sections 8.2.3.1 and 8.2.3.2) and risk evaluations (Section 8.2.3.3) are discussed in the context of the presumptive remedy framework for CERCLA landfills. The validity of applying the presumptive remedy to the solid waste and soil in the Landfill Area is discussed in Section 8.2.3.4.

8.2.3.1. Conclusions for Overall Landfill Characterization

The nature and extent of solid waste and chemicals in soil within the Landfill Area is adequately characterized to evaluate a focused set of remedial alternatives in the FS. This determination is based in large part on EPA presumptive remedy guidance for CERCLA landfills (EPA, 1993a, 1993b, 1994 and 1996). As discussed in Section 8.2.1, characterization of solid waste is not necessary or appropriate for selecting a response action for the Landfill Area. Instead, existing data were used to answer two questions outlined in EPA guidance for military landfills (EPA, 1996):

- Do landfill contents meet municipal landfill-type waste definition?
- Are military-specific wastes present?

Adequate data exist to answer these questions, as presented in the following paragraphs.

Do landfill contents meet municipal-type waste definition?

The landfill contents meet the municipal-type waste definition, as outlined in EPA guidance, based on the following lines of evidence:

- Risks are low-level (except for potential hot spots): Results of the HHRA indicated that, for both the recreational user and construction worker exposure scenarios, cancer risks are within the acceptable risk range of 10^{-6} to 10^{-4} specified in the NCP (55 Federal Register 8848, March 8, 1990).
- Treatment is impractical due to the volume and heterogeneity of the waste: The landfill covers 22 acres and has an estimated solid waste volume of 473,000 cubic yards (excluding the surrounding soil fill). The solid waste is a heterogeneous mixture of municipal-type waste, construction debris, and industrial waste.
- Waste types include household, commercial, nonhazardous sludge, and industrial solid waste: The predominant constituents of the solid waste are household and commercial refuse and construction debris. Other waste types, found in lower proportion, include industrial solid waste (such as sandblast waste) and waste oils and may include asbestos-containing debris, paint sludge, and solvents.
- Lesser quantities of hazardous wastes are present as compared with municipal wastes: Based on an evaluation of 333 soil samples collected from the intermittent soil fill mixed within the solid waste, nearly all of the hazardous substances detected in Landfill Area soil were of a limited extent relative to the overall waste volume. Several chemicals, such as SVOCs and PCBs, were detected throughout the Landfill Area at concentrations above the RIEC but were not indicative of hot spots.
- Land application units, surface impoundments, injection wells, and waste piles are not included: None of these features are present at the Parcel E-2 Landfill.

Are military-specific wastes present?

Based on the findings of the HRA (NAVSEA, 2004), LLRW may be present in and around the Parcel E-2 Landfill. These wastes consist primarily of buried radioluminescent devices (i.e., devices or instruments covered with paint containing radium-226), but may also include sandblast waste used to decontaminate ships used in atomic testing. As discussed in the radiological addendum to this RI/FS Report, historical records suggest that the volume and activity of LLRW potentially disposed of in the Landfill Area were relatively low (ERRG and Radiological Survey and Remedial Services, LLC, 2011). Information from the removal action at the PCB Hot Spot Area (which extends partially into the Landfill Area) confirmed that LLRW is found in low proportion relative to other waste types. According to EPA guidance, LLRW is considered "low-hazard military-specific wastes" and "generally are no more hazardous than some wastes found in municipal landfills" (EPA, 1996).

Other types of "low-hazard" military-specific wastes include decontamination kits and munitions hardware[8]. Forty-one pieces of MPPEH were encountered in the PCB Hot Spot Area excavation, out of a total excavation volume of 44,500 cubic yards, consisting primarily of expended cartridge casings of various calibers and protective caps, but also included an empty 5-inch practice projectile and a 3-pound

[8] Munitions hardware, as identified in the EPA 1996 guidance, is considered part of the broader munitions debris category used by the U.S. Department of Defense.

practice bomb (TtECI, 2010). Of the 41 MPPEH items discovered in the removal area, 20 items were verified to not present an explosive hazard and were reclassified as MDAS. The remaining 21 MPPEH items appeared to have been subject to previous demilitarization actions and could not be completely inspected by UXO technicians for possible explosive hazards. Although the type, age, and condition of these 21 MPPEH items did not suggest a high potential for residual energetic material, the Navy, as a precautionary measure, properly handled, transported, and disposed of these items as either material documented as an explosive hazard (MDEH) (20 items consisting of expended cartridge casings of various calibers) or munitions and explosives of concern (MEC) (1 item. 3-pound practice bomb) (TtECI, 2010). The only reported munitions storage was at Building S-807 (located in the former Parcel A). This building was a bunker like concrete structure approximately 10 feet wide, 3 feet deep, and 5 feet high that was reportedly used by the Navy to store small caliber munitions for hand-held weapons (AFA and Golder, 1996). Based on this information, decontamination kits and munitions hardware, if present at all, likely would only be found in low proportion relative to other waste types and would be no more hazardous than some wastes found in municipal landfills.

The "low-hazard" military-specific wastes discussed above are distinct from "high-hazard" military-specific wastes, which include chemical warfare agents, artillery, bombs, and other military chemicals. Such high-hazard military-specific wastes may possess unique safety, risk, and toxicity characteristics that require special consideration (EPA, 1996). No anecdotal information, documentation, or physical evidence has been identified that such high-hazard military-specific wastes were ever used at HPS. Further, the shipyard's primary mission of fleet repair and maintenance did not include weapons storage.

8.2.3.2. Conclusions for Characterization of Potential Hot Spots

Existing data are used to identify hot spots within a landfill and to determine if additional characterization and treatment of these hot spots is warranted. EPA guidance poses four specific questions for determining whether or not hot spots require characterization and treatment. If all of the questions can be answered in the affirmative, it is likely that characterization and treatment of hot spots is warranted (EPA, 1993a). The four questions outlined below include the Navy's answers on the potential hot spots in the northern and central portions of the Landfill Area.

<u>Does evidence exist to indicate the presence and approximate location of waste?:</u> Yes. PCBs, 1,4-DCB, and naphthalene have been detected at concentrations greater than 100 times the RIEC at several locations within the Landfill Area.

<u>Is the hot spot known to be a principal threat waste?:</u> No. According to EPA guidance entitled "A Guide to Principal Threat and Low Level Threat Wastes" (EPA, 1991b), principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. The potential

hot spots identified within the northern and central portions of the Landfill Area were found to (1) be located at relatively deep depths (8 to 17 feet bgs); (2) not have migrated to A- or B-aquifer groundwater; (3) be located far from the Parcel E-2 shoreline (390 to 780 feet); and (4) not be connected with the PCB Hot Spot Area (where post-excavation conditions will prompt further analysis as recommended in the FS portions of this report). Based on this information, these potential hot spots are not highly mobile and can be reliably contained based on their depth and relative distance from the shoreline.

Is the waste in a discrete, accessible part of the landfill?: No. The potential hot spots in the northern and central portions of the Landfill Area are located at relatively deep depths (8 to 17 feet bgs) and within the solid waste (rather than at the edge of the waste).

Is the hot spot known to be large enough that its remediation will reduce the threat posed by the overall site, but small enough to consider removal?: No. Based on soil and groundwater data from surrounding areas, the potential hot spots in the northern and central portions of the Landfill Area are not considered large enough that remediation will reduce the potential risk posed by the Landfill Area. Further, these potential hot spots do not drive risk to human health or the environment because of their depth and lack of migration to groundwater.

These findings demonstrate that characterization and treatment of the potential hot spots within the northern and central portions of the Landfill Area is not warranted.

8.2.3.3. Conclusions for Risk Evaluations in Landfill Area

The quantitative HHRA and onshore SLERA determined that several locations in the Landfill Area contain chemical concentrations in soil that result in unacceptable levels of risk to human and ecological receptors. However, most of these areas (excluding the potential hot spots discussed in Section 8.2.3.2) contain chemical concentrations that are low relative to their corresponding risk-based thresholds (such as, human-health RBCs or ecological PSCs). In addition, areas with no data may contain chemical concentrations that would result in risks of the same relative magnitude as found elsewhere in the Landfill Area. Therefore, the solid waste and soil throughout the Landfill Area warrants analysis in the FS but this analysis can be focused, consistent with EPA's RI/FS process for CERCLA landfills, which includes guidance specific to military landfills (EPA, 1996).

As discussed in Section 8.2.1.3, there are portions of the PCB Hot Spot Area that after the TCRA (1) extend into the Landfill Area and contain PCB concentrations in soil greater than 100 times the RIEC, (2) are in close proximity to San Francisco Bay, and (3) have affected groundwater conditions. Based on this information, conditions within the PCB Hot Spot Area are recommended for further analysis in the FS portions of this report. This evaluation may include hot spot removal and waste consolidation actions.

8.2.3.4. Application of the Containment Presumptive Remedy

As discussed in Section 1.4.1, the EPA has developed a specialized RI/FS process for landfill sites (EPA, 1991a, 1993a, 1993b, 1994, and 1996) that, provided certain conditions are met, supports selection of a containment presumptive remedy. EPA guidance includes a decision framework for evaluating the applicability of the containment presumptive remedy to military landfills (EPA, 1996). The six-step process includes the following considerations:

- What information should be collected?
- How may land reuse affect remedy selection?
- Do landfill contents meet municipal landfill-type waste definition? (discussed in Section 8.2.3.1)
- Are military-specific wastes present? (discussed in Section 8.2.3.1)
- Is excavation of contents practical?
- Can the presumptive remedy be used?

The following paragraphs present the Navy's assessment of the applicability of the containment presumptive remedy relative to the above six steps. The results of the assessment are presented graphically on Figure 8-1.

Step 1 – What information should be collected?

Available information on the waste types, operating history, and estimated size and volume of the Parcel E-2 Landfill were compiled and are summarized in Section 8.2.1.

Step 2 – How may land reuse affect remedy selection?

According to the 2010 amended Redevelopment Plan, most of the planned reuse for Parcel E-2 is open space, including all of the Parcel E-2 Landfill. Therefore, the planned reuse of the Parcel E-2 Landfill is compatible with the containment presumption.

Step 3 – Do landfill contents meet municipal-type waste definition?

The landfill contents meet the municipal-type waste definition, as summarized in Section 8.2.3.1. Although wastes within the Parcel E-2 Landfill meet the municipal-type waste definition outlined in EPA guidance, the presence of military-specific wastes warrants an additional evaluation step, which is discussed below.

Step 4 – Are military-specific wastes present?

As discussed in Section 8.2.3.1, military-specific wastes present (or potentially present) in and around the Parcel E-2 Landfill are considered "low-hazard military-specific wastes," that is "generally are no more hazardous than some wastes found in municipal landfills" (EPA, 1996). As shown on Figure 8-1, EPA guidance supports the application of the containment presumptive remedy when such low-hazard military-specific wastes are present.

Step 5 – Is excavation of contents practical?

The effectiveness, implementability, and cost of excavating the Parcel E-2 Landfill was evaluated, consistent with EPA guidance (1996) and the NCP (55 Federal Register 8849, March 8, 1990), in order to answer this question. The estimated excavation volume of 1,008,250 cubic yards, includes the solid waste volume (473,000 cubic yards), the volume of overlying soil cover (393,500 cubic yards), and the volume of the soil below the solid waste (as deep as 13 feet below msl) that would be removed to support "clean closure" of the waste disposal unit (141,750 cubic yards). Experience from removal actions in Parcel E-2 has provided useful information for evaluating potential waste excavation, including field production rates, types of wastes encountered, and level of effort to implement site-specific requirements (e.g., the requirement to screen all material excavated in Parcel E-2 for radioactivity). However, the volume of the Parcel E-2 Landfill and surrounding soil fill is nearly 20 times the total volume of material removed at the Metal Slag Area and PCB Hot Spot Area (52,700 cubic yards).

Excavation is possible but may be very difficult to implement because of the depth of waste at the landfill, the proximity to surface water (the bay), and the proximity to adjacent non-Navy property. Difficulties associated with the removal of solid waste and soil from the landfill include:

- Slope stability during excavation
- Surface water control to prevent inundation resulting from tides or stormwater
- Groundwater inflow control for excavation below the water table
- Radiological screening, characterization, and confirmation sampling of all soil and debris transported from the site (for disposal and treatment) and to the site (for backfill and restoration)
- Locating and importing multiple, large-volume sources of backfill material that are free of contamination and do not contain metals concentrations in excess of existing ambient levels
- Control of potential releases of chemicals from waste and soil during removal and transport through the surrounding neighborhood

The implementation issues cited above also reflect issues regarding the short-term effectiveness of excavating the Parcel E-2 Landfill. For example, worker safety could be affected detrimentally by any problems in maintaining a stable excavation and controlling water inflow, considering the proximity of the deep excavations (down to 13 feet below msl) to the bay. In addition, excavation of the landfill would likely require multiple years of continuous construction to complete, and the resulting traffic, noise, and emissions from heavy equipment operation would affect the local population. Also, these implementation issues directly correspond to the high projected costs. The primary factors that result in the high costs of excavation and disposal are:

- Large volume of solid waste, soil, and sediment to be excavated and disposed of off site
- Large volume of solid waste, soil, and sediment to be screened for radiological contamination, sampled for characterization, and transported and treated or disposed of off site
- Extensive controls required to minimize, manage, treat (if necessary), and dispose of contaminated water during excavation and waste segregation processes
- Large volume of imported clean fill required for backfill to restore the site

Overall, the issues regarding the short-term effectiveness, implementation, and cost of excavating the Parcel E-2 Landfill do not offset the long-term effectiveness of such an action. This assessment is supported by EPA guidance (EPA, 1996), which states that "although no set excavation volume limit exists, landfills with a content of more than 100,000 cubic yards (approximately 2 acres, 30 feet deep) would normally not be considered for excavation."

Step 6 – Can the presumptive remedy be used?

Based on the information outlined in the paragraphs above, the containment presumptive remedy meets all of the criteria specified in EPA guidance; therefore, it is well-suited to prevent exposure to solid waste and soil in the Landfill Area. In addition, the containment presumption also can be applied to landfill gas and contaminated A-aquifer groundwater or leachate emanating from the landfill.

Some members of the local community have expressed a strong desire for the Navy to thoroughly evaluate excavation of the landfill. To provide information to support the community's review of potential remedial alternatives for Parcel E-2, the Navy has agreed to evaluate excavation of the landfill as part of this report.

8.3. LANDFILL GAS

The following subsections summarize the nature and extent of landfill gas (Sections 8.3.1 and 8.3.2), the results of the landfill gas risk evaluations (Section 8.3.3), and the overall RI conclusions for the landfill gas (Section 8.3.4).

8.3.1. Landfill Gas Characterization

The initial landfill gas characterization, consisting of temporary soil gas borings and 21 permanent GMPs, determined that methane was present at concentrations exceeding 25 percent of the LEL along the northern side of the Parcel E-2 Landfill. Methane was also detected on the UCSF compound, located north of the landfill, at concentrations exceeding the LEL. Methane was not detected at concentrations exceeding 25 percent of the LEL in locations along Crisp Avenue (north of the UCSF compound) or to the east, south, and west of the Landfill.

Several NMOCs were detected in both the temporary soil gas borings and the permanent GMPs, with the highest concentrations detected in GMPs around the northern perimeter of the landfill and within the UCSF compound. NMOC concentrations were detected in the GMPs located along Crisp Avenue, but at lower concentrations than detected at the GMPs along the northern perimeter of the landfill and within the UCSF compound.

Upon completion of the landfill gas characterization study, the extent of landfill gas was determined to be at the northern edge of the UCSF compound. The estimated extent of landfill gas, based on methane concentrations less than 1.25 percent by volume (equivalent to regulatory limit established in 27 CCR § 20921 for on-site structures), extends slightly (less than 150 feet) beyond the boundary of the Parcel E-2 Landfill to the west, east, and south. The extent of landfill gas to the west, east, and south is within the prescribed regulatory limit of 5 percent methane by volume in air (equal to methane's LEL) at the property and parcel boundary.

8.3.2. Landfill Gas Monitoring and Control Activities

Upon completion of the landfill gas characterization, the Navy conducted the landfill gas TCRA to (1) remove landfill gas and reduce subsurface methane concentrations at the UCSF compound to below the LEL (5 percent methane by volume in air); and (2) control future landfill gas migration to off-site areas. The TCRA consisted of active landfill gas extraction, post-extraction monitoring, and a response action to address potential methane migration pathways through the landfill gas control system (TtEMI, 2004a).

Ongoing landfill gas monitoring and gas control system operation is being conducted under the Interim Landfill Gas Monitoring and Control Plan (TtEMI and ITSI, 2004c). The landfill gas monitoring network, which includes perimeter GMPs and various surface and subsurface locations, was designed in accordance with 27 CCR and ensures that any landfill gas migrating beyond the regulatory boundary will be detected. Monitoring is performed on a regular basis and includes notification and response procedures in the event that hazardous concentrations of landfill gas (as discussed in Section 8.3.3) are detected beyond the fence line of the landfill and beneath the UCSF compound.

8.3.3. Landfill Gas Risk Evaluations

Human exposure to subsurface air emanating from the landfill (referred to as landfill gas) can pose a potential risk in two ways: (1) explosive conditions due to concentrations of methane at or above the LEL and (2) inhalation of NMOCs that, above certain concentrations, have associated cancer and noncancer health effects. Evaluation of these potential risks was performed consistent with regulations outlined in 27 CCR. Performance standards for controlling gas emanating from closed landfills are provided in 27 CCR § 20921 and are summarized as follows:

- Concentrations of methane gas must not exceed 1.25 percent by volume in air (25 percent of the LEL) within on-site structures.
- Concentrations of methane gas migrating from the landfill must not exceed 5 percent by volume in air (the LEL) at the facility property boundary or an alternative boundary approved in accordance with 27 CCR § 20925.
- Trace gases (that is, NMOCs) will be controlled to prevent adverse acute and chronic exposure to toxic and carcinogenic compounds.

For the landfill gas characterization, the evaluation methodology for methane data involved comparing field and laboratory data collected from the monitoring network against the numeric 27 CCR limits. The evaluation methodology for NMOCs involved performing risk assessments on soil gas data collected from permanent GMPs using the Johnson and Ettinger vapor intrusion model (EPA, 2003a). A risk assessment was conducted prior to operation of the gas extraction system to evaluate potential human health risks resulting from the low levels of NMOCs detected in GMPs along Crisp Avenue (see Appendix A to this report). An additional risk assessment was performed on NMOC data from GMPs within the UCSF compound (see Appendix F to this report). Cancer risk calculations for GMPs along Crisp Avenue, using the laboratory results, ranged from 6.4×10^{-7} to 2.0×10^{-8} for a residential exposure scenario. Cancer risk calculations for the GMPs on the UCSF compound ranged from 4.0×10^{-7} to 8.8×10^{-9} for an industrial exposure scenario.

Field measurements for NMOCs, collected during the same time frame as the laboratory analytical data, ranged from 0 ppmv to 51 ppmv. Recognizing that a 10-fold increase in the cancer risks would require a 10-fold increase in the NMOC measurements, 500 ppmv was selected as the action level for NMOCs detected at GMPs included in the monitoring network. If the concentration of total NMOCs increases from the 50-ppmv range to above 500 ppmv, additional sampling and analysis for NMOCs and further evaluation of risk to human health would be warranted (TtEMI and ITSI, 2004c). No concentrations of total NMOCs above 500 ppmv have been detected during monitoring performed since January 2004.

For the ongoing landfill gas monitoring, the evaluation methodology for methane data involves comparing field data against the conservative action levels (1 percent for various surface and subsurface locations; 2.5 percent for all GMPs) selected to minimize the likelihood of exceeding the 27 CCR limits. The evaluation methodology for NMOCs involves comparing field data from surface and subsurface locations (not from GMPs) with a standard health and safety limit of 5 ppmv and comparing field data from GMPs against the 500 ppmv action level discussed above.

8.3.4. Conclusions for Landfill Gas

Data collected as part of the landfill gas characterization study, the TCRA, and ongoing landfill gas monitoring have adequately defined the nature and extent of landfill gas at Parcel E-2. However, the potential presence of subsurface utilities within the eastern portion of the Landfill Area (Figure 1-4) should be verified. Such utilities may serve as preferential pathways for gas migration; however, previous soil gas measurements in the vicinity (Figure 4-3) indicated methane has not been detected above 25 percent of the LEL. An investigation of this possible preferential pathway will be scoped, performed, and summarized as part of the RD process. This investigation may involve geophysical techniques and exploratory test pits.

Based on evaluation of available data from January 2004 through June 2010, the gas control system is functioning to control the migration of hazardous levels of methane beyond the northern fence line of the Parcel E-2 Landfill. In January and February 2006, hazardous levels of methane were detected at the fence line of the landfill. The Navy promptly performed active extraction to control the migration of hazardous levels of methane beyond the fence line of the landfill. The efficacy of the gas control system along the northern landfill boundary, as well as gas monitoring data (for both methane and NMOCs) from around the remainder of the landfill, supports the nature and extent of landfill gas as presented in this report.

The potential exists for methane, if not properly controlled, to migrate beyond the Parcel E-2 Landfill boundary at concentrations that may be hazardous to human health. Therefore, continued monitoring and control (through either passive or active methods) of methane should be included as part of any remedial alternative that leaves Landfill Area solid waste in place. Additional studies are planned, in conjunction with the RD, to more thoroughly evaluate soil gas concentrations in the Panhandle Area and East Adjacent Area and to assess whether methane or NMOCs are present in the areas at concentrations that may be hazardous to human health.

8.4. SOIL AND ISOLATED SOLID WASTE IN THE PANHANDLE AND EAST ADJACENT AREAS

The following subsections summarize the nature and extent of isolated solid waste locations (Section 8.4.1) and chemicals in soil (Section 8.4.2) found in the Panhandle and East Adjacent Areas. The risk assessments conducted in the adjacent areas are summarized in Section 8.4.3, and an overview of the RI conclusions for the adjacent areas is presented in Section 8.4.4.

8.4.1. Nature and Extent of Isolated Solid Waste Locations

The nature and extent of solid waste in the Panhandle and East Adjacent Areas is distinct from the solid waste defined in the Landfill Area. Specifically, fill material in the Panhandle and East Adjacent Areas consists primarily of soil and rock, with isolated solid waste locations that are not contiguous with solid waste in the Landfill Area. In addition, solid waste within the adjacent areas consists of inert construction debris, with isolated locations of industrial wastes (such as sandblast waste, metal slag, radioluminescent devices, and oily waste) and putrescible construction debris (such as wood). Although these waste types are also found in the Landfill Area, the municipal-type waste found in the Landfill Area is not found in the Panhandle and East Adjacent Areas.

The Navy reviewed aerial photographs and logs from more than 280 test pits, soil borings, monitoring wells, and GMPs from various investigations at and adjacent to Parcel E-2 to identify locations outside the landfill that contain industrial wastes, municipal-type wastes, or construction debris. Results of the evaluation are summarized in the table below and depicted on Figure 4-1.

Waste Type	Number of Waste Locations in Panhandle Area [a]	Number of Waste Locations in East Adjacent Area [a]
Nonputrescible construction debris	28	10
Putrescible construction debris	20	21
Sandblast waste	0	9
Sandblast waste and putrescible construction debris	0	3
Total:	48 (87 total borings and test pits)	43 (117 total borings and test pits)

Notes:

a Includes borings in the Shoreline Area in close proximity to the Panhandle and East Adjacent Areas, and also includes borings and test pits installed only to identify soil lithology (i.e., no soil samples were collected for chemical analysis).

Construction debris encountered in both the Panhandle and East Adjacent Areas include concrete, brick, wood, and asphalt, with limited amounts of ceramic, glass, and metals (primarily as wire or rebar in concrete). With the exception of wood, the remaining types of construction debris are considered inert and are not expected to generate methane gas or leachate that would create potential risks to human health or the environment.

Industrial wastes have been encountered in the Panhandle and East Adjacent Areas during the Metal Slag Area and PCB Hot Spot Area removal actions. Industrial wastes encountered within the Metal Slag Area (in the Panhandle Area) include metal slag and debris containing low-level radiological material and devices (TtECI, 2007b). All excavated soil and waste removed from the Metal Slag Area was handled and screened as potential LLRW based on the findings of the HRA (NAVSEA, 2004). Out of a total excavated volume of 8,200 cubic yards, approximately 74 cubic yards of soil and sediment was segregated as radiologically impacted. In addition, 32 radiological devices, 15 cubic yards of radiological debris (primarily fire bricks), and approximately 30 cubic yards of metal debris were identified within the removal area (Navy, 2006a and 2006b; TtECI, 2007b). In addition to this radiologically impacted debris, six waste drums were recovered from the removal area and were characterized prior to off-site disposal. The drums, which were discovered in varying degrees of deterioration, contained grease, soil, plastic, metal, and wood. Waste characterization data indicated that five of the six drums contained various chemicals, including PCBs and petroleum hydrocarbons; the sixth drum contained elevated activities of radium-226 (TtECI, 2007b).

Industrial wastes encountered within the PCB Hot Spot Area (in the East Adjacent Area) include oily wastes, radioluminescent devices, and sandblast waste (Navy, 2005b through 2005f). All excavated soil and waste from the PCB Hot Spot Area removal action was handled and screened as potential LLRW based on the findings of the HRA (NAVSEA, 2004). Out of a total excavated volume of 44,500 cubic yards, 533 cubic yards of soil and fire brick was segregated as radiologically impacted. Also, 40 radiological devices, 78 cubic yards of metal debris, and 19 pieces of other radioactively contaminated debris were identified within the removal area (TtECI, 2007a).

Also, 110 drums and 537 assorted waste containers were recovered from the central portion of the PCB Hot Spot Area excavation and were characterized prior to off-site disposal. The drums, which were discovered in varying degrees of deterioration, contained grease, oil, soil, asphalt, and tar substances. Waste characterization data indicated that the drums contained various chemicals, including PCBs and pesticides. Two of the drums contained mixed waste with radiological contamination. The small containers contained various laboratory chemicals, ranging from strong acids and bases to solvents, alcohols, and inorganic salts (TtECI, 2007a). In addition, 41 pieces of MPPEH were encountered in the excavation area, consisting primarily of expended cartridge casings of various calibers and protective caps, but also included an empty 5-inch practice projectile and a 3-pound practice bomb (TtECI, 2010). Of the 41 MPPEH items discovered in the removal area, 20 items were verified to not present an explosive hazard and were reclassified as MDAS. The remaining 21 MPPEH items appeared to have been subject to previous demilitarization actions and could not be completely inspected by UXO technicians for possible explosive hazards. Although the type, age, and condition of these 21 MPPEH items did not suggest a high potential for residual energetic material, the Navy, as a precautionary measure, properly handled, transported, and disposed of these items as either material documented as an explosive hazard (MDEH) (20 items consisting of expended cartridge casings of various calibers) or munitions and explosives of concern (MEC) (1 item. 3-pound practice bomb) (TtECI, 2010).

The noncontiguous and heterogeneous nature of the fill material within the Panhandle and East Adjacent Areas results in a high degree of uncertainty that this fill and the chemicals in soil can be delineated into discrete zones for remediation activities.

8.4.2. Nature and Extent of Chemicals in Soil

The soil data set within the Panhandle and East Adjacent Areas was derived from 754 soil samples (113 soil borings, 113 excavation grids within the PCB Hot Spot Area and Metal Slag Area, and 14 test pits) collected within these areas. Metals, pesticides, PCBs, dioxins and furans, SVOCs, and petroleum hydrocarbons were detected at concentrations exceeding RIECs in soil samples collected in the Panhandle and East Adjacent Areas. A summary of these chemical detections above the RIECs is presented below.

- Eight metals (antimony, arsenic, cadmium, chromium, iron, lead, vanadium, and zinc) were detected at concentrations exceeding RIECs at various depths. Arsenic and lead were the metals detected most frequently at concentrations exceeding RIECs. The metals exceedances were found more frequently in samples collected at depths of 0 to 10 feet bgs.
- Four pesticides (4,4'-DDE, 4,4'-DDT,dieldrin, and heptachlor epoxide) were detected at concentrations exceeding RIECs at depths of 0 to 10 feet bgs.
- Total PCBs (high risk) were detected at concentrations exceeding the RIEC at all depths within the Panhandle and East Adjacent Areas, except at depths greater than 10 feet bgs in the Panhandle Area.
- Dioxins and furans were detected at concentrations exceeding RIECs in the Panhandle Area at depths greater than 2 feet bgs.
- SVOCs were detected at concentrations exceeding RIECs in most depths ranges (except at depths greater than 10 feet bgs in the East Adjacent Area). SVOCs were detected most frequently at concentrations exceeding RIECs from 0 to 10 feet bgs.
- VOCs were detected at concentrations exceeding RIECs in the East Adjacent Area from 0 to 10 feet bgs.
- Total TPH (the summation of TPH-g, TPH-d, and TPH-mo) was detected at concentrations exceeding the TPH source criterion (3,500 mg/kg) in most depths ranges (except at 2 to 10 feet bgs in the Panhandle Area and greater than 10 feet bgs in the East Adjacent Area).

For the PCB Hot Spot Area TCRA, post-excavation soil samples were collected and analyzed for PCBs and petroleum hydrocarbons. In addition to PCB and petroleum hydrocarbons analyses, post-excavation sidewall samples were also analyzed for pesticides, metals, and, if petroleum hydrocarbons were present, PAHs. Additional analysis for VOCs, SVOCs, and pesticides were performed for bottom samples collected in the vicinity of the buried drums. Analytical results for post-excavation samples are presented in Section 4.4.2 of this RI/FS Report. The reported concentrations of metals, PCBs, pesticides, SVOCs, and petroleum hydrocarbons in these samples are recommended for further analysis in the FS portions of this report.

For the Metal Slag Area TCRA, post-excavation soil samples were collected and analyzed for metals, PCBs, and pesticides. Because the focus of the TCRA was to remove radiological material, these chemical results did not prompt additional excavation activities and were intended only to supplement the soil characterization in the Metal Slag Area. Post-excavation chemical sampling results are summarized in Section 4.3.2. The reported concentrations of PCBs and several metals in these samples warrant further analysis in the FS portions of this report.

Based on the data presented in Table 4-24, soil contamination is less extensive within East Adjacent Area soil at depths greater than 10 feet bgs. This finding is attributed to the fact that most fill material in these areas was not associated with shipyard operations. In addition, deep soil within the East Adjacent Area consists of either natural sediments or fill material placed during expansion of the shipyard in the early 1940s.

Soil contamination is more widely distributed in the Panhandle Area and the shallow zones (0 to 10 feet bgs) of the East Adjacent Area. The heterogeneous contaminant distribution in these areas indicates that fill material placed at Parcel E-2 during shipyard operations may contain unacceptable levels of contamination. The heterogeneous contaminant distribution makes delineation of potential areas of concern problematic. This problem is evidenced by the findings of the SDGI, which was only partially successful in delineating known and potential soil contamination in the Panhandle and East Adjacent Areas (further discussed in Section 4.5.4).

Based on the information presented in Section 4.4.2, the following potential hot spots were identified in the East Adjacent Area:

- Edges of PCB Hot Spot Area excavation in southern portion of East Adjacent Area (0 to 10 feet bgs): 16 samples (15 locations) contained total high risk PCBs at concentrations greater than 100 times the RIEC (0.74 mg/kg). Most of the locations were along the western and southwestern sidewall of the PCB Hot Spot Area excavation. As discussed in Section 3.8.8, oil-stained soil and free-phase product were observed along and adjacent to this sidewall during the removal action. In addition, 1 of the 18 locations (Grid 159 sidewall) also contained heptachlor epoxide at a concentration greater than 100 times the RIEC (0.19 mg/kg).
- Central portion of the East Adjacent Area (2 to 10 feet bgs): Two samples (IR01TA07A and IR01TA07B, 4 feet bgs) contained total high risk PCBs at concentrations greater than 100 times the RIEC (0.74 mg/kg). IR01TA07A and IR01TA07B are located about 50 feet apart. Also, two samples (IR04B020 and IR04B025; both at a depth of 4 feet bgs) contained lead at concentrations greater than 100 times the RIEC (800 mg/kg). IR04B020 and IR04B025 are located about 70 feet apart.

These potential hot spots will be further evaluated in the FS portions of this report. This evaluation may include hot spot removal and waste consolidation actions.

Despite the inherent difficulty in delineating potential point sources of soil contamination within heterogeneous fill material, the characterization efforts from the RI, NDGI, and SDGI have provided sufficient data to evaluate potential human health and ecological risk at Parcel E-2 because past sampling locations have focused, to the extent practical, on the most likely contaminant sources (based on a comprehensive review of historic aerial photographs and any visual evidence of contamination).

8.4.3. Risk Assessment for the Panhandle and East Adjacent Areas

The following subsections present the results of the HHRA and SLERA performed on soil data within the Panhandle Area and the East Adjacent Area.

8.4.3.1. Human Health Risk Assessment

The quantitative HHRA in the Panhandle and East Adjacent Areas was performed consistent with the methodology described in Section 8.2.2.1. The results of the HHRA were used to support the remedial alternative evaluation for the Panhandle and East Adjacent Areas.

Panhandle Area

For the recreational exposure scenario (Figure 7-2), results of the incremental risk evaluation indicated that the COCs were antimony, arsenic, and lead; several SVOCs (primarily benzo[a]pyrene); dieldrin; and several PCBs (primarily Aroclor-1260). Of the 44 exposure grid cells located either completely or partially within the Panhandle Area, 15 grid cells had EPCs (for soil at 0 to 2 feet bgs) resulting in risk above one or more of the risk thresholds (1×10^{-6} for cancer risk; segregated HI of 1 for noncancer risk; and 155 mg/kg for lead exposure). Of the remaining 29 grid cells, 12 grid cells did not exceed any risk thresholds and 17 grid cells contained no data on which risk calculations could be based. For grid cells with risk above one or more of the risk thresholds (Table 7-3), cancer risks ranged from 4×10^{-8} (for grid cell AB39, which did not exceed the cancer risk threshold of 1×10^{-6} but exceeded the lead exposure threshold) to 6×10^{-4} and noncancer HIs ranged from less than 1 to 6.

For the construction worker exposure scenario (Figure 7-4), results of the incremental risk evaluation indicated that that the COCs were antimony, arsenic, copper, iron, lead, manganese, and vanadium; dioxins; several SVOCs (primarily benzo[a]pyrene); dieldrin; and several PCBs (primarily Aroclor-1260). Of the 44 exposure grid cells located either completely or partially within the Panhandle Area, 13 grid cells had EPCs (for soil from 0 to 10 feet bgs) resulting in risk above one or more of the risk thresholds. Of the remaining 31 grid cells, 19 grid cells did not exceed any risk thresholds and 12 grid cells contained no data on which risk calculations could be based. For grid cells with risk above one or more of the risk thresholds (Table 7-7), cancer risks ranged from 3×10^{-6} to 2×10^{-4} and total noncancer HIs ranged from less than 1 to 20.

East Adjacent Area

For the recreational exposure scenario (Figure 7-2), results of the incremental risk evaluation indicated that the COCs were arsenic and lead, several SVOCs (primarily benzo[a]pyrene), dieldrin, heptachlor epoxide, and Aroclor-1260. Of the 38 exposure grid cells located either completely or partially within the East Adjacent Area, 17 grid cells had EPCs (for soil at 0 to 2 feet bgs) resulting in risk above one or more of the risk thresholds. Of the remaining 21 grid cells, 7 grid cells did not exceed any risk thresholds and 14 grid cells contained no data on which risk calculations could be based. For grid cells with risk above one or more of the risk thresholds (Table 7-3), cancer risks ranged from 2×10^{-6} to 6×10^{-4} and noncancer HIs ranged from less than 1 to 100.

For the construction worker exposure scenario (Figure 7-4), results of the incremental risk evaluation indicated that the COCs were antimony, arsenic, lead, several SVOCs (primarily benzo[a]pyrene), 4,4'-DDT, dieldrin, heptachlor epoxide, and Aroclor-1260. Of the 38 exposure grid cells located either completely or partially within the East Adjacent Area, 23 grid cells had EPCs (for soil at 0 to 10 feet bgs) resulting in risk above one or more of the risk thresholds. Of the remaining 15 grid cells, 5 grid cells did not exceed any risk thresholds and 10 grid cells contained no data on which risk calculations could be based. For grid cells with risk above one or more of the risk thresholds (Table 7-7), cancer risks ranged from 2×10^{-6} to 6×10^{-4} and total noncancer HIs ranged from less than 1 to 900. The highest cancer and noncancer risks were at grid cells AI35, AJ35 and AJ36, where the western and southwestern sidewall of the PCB Hot Spot Area excavation is located. Risk in these grid cells were reduced slightly following the removal action (highest cancer risk was reduced from 1×10^{-3} to 6×10^{-4}); however, the remaining chemical concentrations along the western and southwestern sidewall of the PCB Hot Spot Area excavation (primarily heptachlor epoxide, and Aroclor-1260) continue to drive risk.

8.4.3.2. Screening-Level Ecological Risk Assessment

Panhandle Area

Concentrations of cadmium, copper, lead, manganese, mercury, vanadium, zinc, HMW PAHs exceeded both PSCs (adjusted by HPALs, as appropriate), and these chemicals are considered a potential threat to birds and mammals exposed to soil in the Panhandle Area. As shown on Figure 7-5, 27 out of 72 locations in the Panhandle Area contained chemical concentrations above the PSCs (adjusted by HPALs, as appropriate).

East Adjacent Area

Concentrations of cadmium, copper, lead, mercury, nickel, vanadium, zinc, total DDT, and total PCBs exceeded both PSCs (adjusted by HPALs, as appropriate), and these chemicals are considered a potential threat to birds and mammals exposed to soil in the East Adjacent Area. As shown on Figure 7-5, 36 out of 89 locations in the East Adjacent Area contained chemical concentrations above the PSCs (adjusted by HPALs, as appropriate).

8.4.3.3. Adequacy of Risk Assessment Data Set

The data distribution within the Panhandle and East Adjacent Areas does not support an exhaustive evaluation of potential human health and ecological risks throughout the areas because past sampling locations have focused, to the extent practical, on the most likely contaminant sources (based on a comprehensive review of historic aerial photographs and any visual evidence of contamination). While the resulting biased data set provides conservative estimates of potential chemical exposures, it also results in numerous areas having no data on which risk calculations can be based.

There are two potential solutions to this problem: (1) collect additional data to characterize risk in areas currently with no data, or (2) assume that grid cells with no data may contain chemical concentrations that could result in risks of the same relative magnitude as found elsewhere in the Panhandle and East Adjacent Areas. Given the heterogeneous contaminant distribution in the adjacent areas, the collection of additional data would not be the most expeditious or cost-effective means of protecting human health and the environment; rather, the assumption that areas with no data may cause unacceptable risk is considered the most prudent course of action.

8.4.4. Conclusions for Isolated Solid Waste, Soil, and Sediment in Panhandle and East Adjacent Areas

As discussed in Section 1.4, the characteristics of the adjacent areas (specifically, areas of soil fill with isolated solid waste) require consideration more typical of a standard RI/FS. Accordingly, this report has included a detailed nature and extent evaluation and quantitative risk assessments for the adjacent areas.

The nature and extent evaluation determined that, despite collection of over 754 soil samples that targeted known or suspected areas of contamination, the site heterogeneities have led to a number of areas in the Panhandle and East Adjacent Areas where chemical concentrations exceeding RIECs are not completely delineated. These heterogeneous site conditions present severe challenges to completing a standard investigation and cleanup for a point source or sources. This fact was evidenced by the findings of the SDGI, which was designed specifically to delineate areas of known contamination (based on past chemical detections and a detailed review of aerial photographs), but was only partially successful in this effort. In light of this fact, additional effort spent further characterizing the adjacent areas would not expedite cleanup of Parcel E-2, nor would it enhance protection of human health and the environment. However, it is acknowledged that additional characterization may be required to support future RD efforts. For example, if hot spot removal is pursued in conjunction with containment technologies, additional characterization might be needed prior to the removal. Specific DQOs for additional site characterization will be developed as needed as part of future response activities (e.g., RD or removal action).

The risk assessments found numerous areas in the East Adjacent Area and several more localized areas in the Panhandle Area with surface soil concentrations that posed an unacceptable risk to humans and wildlife. The combined results of the HHRA (for recreational users) and the SLERA (for terrestrial birds and mammals) are shown on Figure 8-2. Figure 8-2 shows all soil samples were collected from 0 to 3 feet bgs. A study of this data distribution reveals that most HHRA grid cells that did not exceed any of the risk thresholds typically contained two or fewer data points. Given the known heterogeneity throughout Parcel E-2, a conclusion that soil concentrations throughout these grid cells do not pose unacceptable risk should be viewed with a high degree of uncertainty. This uncertainty coupled with the presumption that grid cells with no data may cause unacceptable risk, results in an overall conclusion that soil throughout the Panhandle and East Adjacent Areas should be considered for remedial action in the FS. In addition, these heterogeneous site conditions support the recommendation to develop a focused set of remedial alternatives in the FS and to evaluate their uniform implementation across the adjacent areas as the most expeditious and cost-effective means of protecting human health and the environment.

The isolated solid waste locations in the Panhandle and East Adjacent Areas were found to consist primarily of construction debris. With the exception of wood, the types of construction debris in the adjacent areas are considered inert and are not expected to generate methane gas or leachate that would create potential risks to human health or the environment. Therefore, remedial action to specifically remove these isolated solid waste locations is not required. However, the potential exists for the same types of industrial waste that were encountered in the Metal Slag Area and PCB Hot Spot Area (specifically, sandblast waste and radioluminescent devices) to be encountered elsewhere in the Panhandle and East Adjacent Areas. The potential presence of these waste types should be considered in the remedial options analysis.

8.5. GROUNDWATER

The information derived from the field investigations and ongoing monitoring (through April 2005) was used to define the nature and extent of chemicals in groundwater at Parcel E-2. The complete nature and extent evaluation is included in Section 5, and the results of the HHRA are in Section 7. Summaries of the results of these evaluations are presented in the following subsections. Section 8.5.1 summarizes the results of the nature and extent evaluation, and a synopsis of the quantitative HHRA for Parcel E-2 groundwater is presented in Section 8.5.2. A summary of the RI conclusions is presented in Section 8.5.3.

8.5.1. Nature and Extent of Chemicals in Groundwater

Groundwater contamination has been confirmed through sampling across Parcel E-2 in both the A-aquifer and uppermost B-aquifer. The lateral and vertical extent of chemicals in groundwater has been defined across most of Parcel E-2 through a series of investigations and the ongoing groundwater monitoring program. The extent of chemicals in groundwater, however, is not completely defined along the Parcel E-2 shoreline. The following list briefly summarizes the main findings of the nature and extent evaluation and the major areas of concern with respect to chemicals in groundwater at Parcel E-2.

- Cyanide was detected at elevated concentrations throughout the A- and B-aquifer perimeter wells in Parcel E-2; however, the highest concentrations of cyanide were in samples collected from wells within the Landfill Area. Recent elevated concentrations (exceeding RIEC) and, in some cases, persistent concentrations of cyanide in groundwater wells located along the perimeter of the parcel indicate that the extent of cyanide is not adequately delineated.
- Ammonia was detected at elevated concentrations throughout the A- and B-aquifers in the Landfill Area. These concentrations are indicative of the decomposition of natural organic matter and organic waste material in the landfill. Elevated concentrations (exceeding the RIEC) of un-ionized ammonia are also present in wells located along the bay shoreline and further inland in the northern portion of the Panhandle Area, adjacent to the Landfill Area. Upon contact with bay water, un-ionized ammonia is oxidized to nitrite, then nitrate. The oxidation of ammonia reduces the dissolved oxygen in the bay water and may be harmful to aquatic life.
- Nitrate concentrations exceeding the RIEC are persistent at well IR01MW53B, located along the northern shoreline of the Panhandle Area. The extent of nitrate is not adequately delineated in the B-aquifer at this shoreline location.
- Sulfide was detected at elevated concentrations in monitoring wells throughout Parcel E-2. In particular, wells near the shoreline display elevated and persistent concentrations of sulfide in groundwater that may migrate to San Francisco Bay. The extent of sulfide is not adequately delineated.
- Recently detected concentrations of antimony, chromium, lead, and zinc exceeded their respective RIECs in groundwater along the Landfill Area shoreline in the PCB Hot Spot Area. Concentrations in groundwater may be attenuating as a result of the PCB Hot Spot Area removal action, but this hypothesis can only be confirmed through ongoing monitoring in this area. Until this data gap is addressed, the extent of these metals is not considered adequately delineated in the northern portion of the PCB Hot Spot Area, along the shoreline.
- Persistent barium concentrations exceeding the RIEC (504 μg/L) exist in A-aquifer groundwater in the southern portion of the Panhandle Area and along the Landfill Area shoreline. Because the extent of barium beyond the Parcel E-2 shoreline is unknown, groundwater with barium concentrations exceeding the RIEC is potentially migrating toward San Francisco Bay.
- Recently detected concentrations of copper, lead, and zinc exceeded the A-aquifer RIEC in groundwater along the northern shoreline of the Panhandle Area, where these dissolved metals are potentially migrating to San Francisco Bay. Ongoing monitoring in this area may be used to further delineate the extent of metals in groundwater at this location and may be used to make recommendations on future remedial actions.
- For metals in groundwater, ambient concentrations are a contributing factor for the wide variety of detections in the A-aquifer; however, past site activities at Parcel E-2, which include disposal of industrial wastes, also contribute to the metals reported in groundwater. Metals concentrations slightly exceeding HGALs were treated and delineated as RIEC exceedances in this evaluation, but they may be due to natural variations in background concentrations.

- Concentrations of total PCBs consistently exceed the RIEC in A-aquifer wells located near the sheet-pile wall, along the shoreline in the Landfill Area. Historical data indicated that PCB concentrations generally decreased over time at the site. In addition, the removal action that was performed in the PCB Hot Spot Area along the Parcel E-2 shoreline removed source soil and is expected to result in reduced dissolved concentrations in Parcel E-2 aquifers. The removal action performed at the PCB Hot Spot Area will also probably reduce source concentrations of other chemicals (e.g., SVOCs) detected in the area. Data collected from temporary and replacement wells in the vicinity of the PCB Hot Spot Area, although not extensive, suggest that attenuation is occurring.
- Historical total TPH concentrations in groundwater in wells IR01MW43A and IR01MWI-3 exceeded the TPH criterion in samples collected between 1991 and 2005. Total TPH concentrations in IR01MW43A and IR01MWI-3 continued to exceed their respective RIECs (4,839 µg/L and 2,092 µg/L) through 2005. Total TPH, as well as other chemical concentrations, in soil will likely be reduced as a result of the soil removal action that was conducted in the collocated PCB Hot Spot Area; however additional monitoring is required to confirm whether the removal action has reduced TPH concentrations in groundwater. Concentrations of total TPH in samples collected from temporary monitoring wells within 150 feet of the Parcel E-2 shoreline in the Landfill Area and northern Panhandle Area exceed A-aquifer RIECs. Total TPH is not adequately delineated in these areas.

The following data gaps were identified during the nature and extent evaluation:

- Data gaps exist for certain chemicals (Table 5-15) along the Parcel E-2 shoreline, where chemical concentrations exceeded RIECs. A method for comparing groundwater data with aquatic criteria to account for chemical attenuation and the nearshore mixing process has been adopted and used in Appendix M to assess the downgradient effect of shoreline groundwater contamination on the San Francisco Bay. However, this method is extremely conservative and may require future refinement to provide more accurate extent information for use during the RD.
- Data gaps exist in areas where the potentially beneficial effects on chemicals concentrations in groundwater by recent soil removal actions or planned construction activities have yet to be evaluated (e.g., removal actions at the PCB Hot Spot Area and Metal Slag Area, and removal of the sanitary sewer line). As confirmation sampling data and future groundwater monitoring data become available, the extent evaluations could be amended to incorporate that information. To date, a single monitoring event was conducted to sample groundwater from temporary wells drilled in the post-removal action areas in question. Results from this event were incorporated into the current nature and extent evaluation, presented herein.

The possibility exists that some chemicals may have not been identified as part of this nature and extent evaluation because some sample reporting limits exceeded the RIECs selected for this evaluation. After evaluating the data, it appears that generally, this issue does not diminish the usability of the data for the purpose of identifying the extent of the most prevalent, risk-driving chemicals in groundwater.

An additional 2 years of recent data collected as part of the BGMP were incorporated into the nature and extent evaluation between the draft and draft final versions of this RI/FS Report. The incorporation of these data addressed several data gaps and further strengthened the nature and extent evaluation. However, data gaps still remain in areas where the amount of additional data was not adequate to completely delineate the extent of a chemical. The ongoing basewide groundwater monitoring continues to contribute useful characterization data to the Parcel E-2 data set. The data set will be supplemented for the RD.

8.5.2. Quantitative Human Health Risk Assessment for Groundwater

For the evaluation of human exposure to groundwater, the HHRA used groundwater monitoring data from the 12 most recent sampling events (through October 2007) from all Parcel E-2 wells to develop a conservative exposure concentration for each potentially complete pathway (based on the 95 percent upper confidence limit). Based on the reasonably anticipated reuse of Parcel E-2 as open space, groundwater pathways are not considered complete for recreational visitors, which are the only receptors associated with planned reuse. Results of the evaluation of beneficial uses of groundwater at Parcel E-2 (see Section 2.2.6 and Appendix I) indicate the following:

- The A-aquifer at HPS was previously determined by RWQCB to be unsuitable as a potential source of drinking water (RWQCB, 2003c). The A-aquifer at Parcel E-2 is also considered to be unsuitable as a potential drinking water source based on federal groundwater classification criteria and an evaluation of SSFs.
- The B-aquifer at Parcel E-2 has moderate potential to be used as a drinking water source, based on available TDS data and an evaluation of SSFs.

Because the potential beneficial use of groundwater in the B-aquifer at HPS includes drinking water, the HHRA includes an evaluation of B-aquifer groundwater for domestic use; the evaluation used both B-aquifer and A-aquifer data because of the potential for vertical hydraulic communication between the A- and B-aquifers in some areas at Parcel E-2. In addition, construction workers were also assumed to be exposed to groundwater in the A-aquifer during trenching activities. For groundwater exposures, risks are the same for the total risk and incremental risk evaluations because a comparison to ambient levels was not conducted for groundwater (see Section K4.4 of Appendix K).

Similar to the soil HHRA, the groundwater HHRA did not include radioactive chemicals as COPCs. Potential risks associated with human exposure to radioactive chemicals at Parcel E-2 will be summarized in the radiological addendum to this RI/FS Report. The following subsections summarize the risk evaluation results, by exposure scenario.

8.5.2.1. Construction Worker Trench Exposure Scenario

Table 7-8 summarizes the risk results from exposure to A-aquifer groundwater for a construction worker trench scenario. The total cancer risk was estimated at 1×10^{-4} and the total noncancer HI was less than 1. The primary risk drivers for the construction worker trench exposure scenario are PAHs, which account for more than 95 percent of the total cancer risk. The most significant cancer risk drivers are benzo(a)pyrene and dibenz(a,h)anthracene because they account for over 75 percent of the risk associated with the trench exposure scenario. However, benzo(a)pyrene and dibenz(a,h)anthracene, among other chemicals listed above, have not been detected in Parcel E-2 groundwater since August 2002. In addition, the extent of most PAHs in Parcel E-2 groundwater has been localized, with maximum concentrations detected at former well IR01MWI-3 in the PCB Hot Spot Area excavation.

The conservatism incorporated into the derivation of the EPC (i.e., using the past 12 quarters of monitoring data to develop exposure concentrations) may overestimate the potential risk for the trench exposure scenario, relative to more recent analytical results. A summary of uncertainties for the HHRA is provided in Appendix K (Table K-17).

8.5.2.2. Domestic Use of Groundwater Exposure Scenario

Table 7-11 summarizes the risk results for the exposure to groundwater from domestic use of the B-aquifer. The total cancer risk was estimated at 5×10^{-3} and the total noncancer HI was 80.

The primary risk drivers for the domestic use of groundwater exposure scenario are arsenic and PCBs, accounting for over 70 percent of the total cancer risk. Another risk driver that contributes significantly to the total cancer risk is benzo(a)pyrene, which accounts for approximately 13 percent of the total cancer risk. The risk evaluation also indicated that the primary noncancer risk drivers include PCBs, metals (arsenic, iron, chromium VI, and thallium), and 4-nitrophenol, which account for over 85 percent of the noncancer risk. The risk assessment results for the domestic use scenario are considered conservative for the following reasons:

- The presence of elevated PCB concentrations (exceeding RIECs) in groundwater at Parcel E-2 is confined to the A-aquifer. PCBs have never been detected in B-aquifer samples. However, because the A- and B-aquifers are hydraulically connected in the northwestern part of the parcel, a conservative risk assessment approach was taken and A-aquifer data were incorporated into the domestic use exposure risk calculations.
- The most significant area of known PCB contamination at the site (the PCB Hot Spot Area) has undergone remediation, which may lead to a reduction in PCB concentrations in the A-aquifer. Data collected from temporary and replacement wells in the vicinity of the PCB Hot Spot Area, although not extensive, suggest that attenuation is occurring.

- As discussed in Section 8.5.1, the only persistent arsenic detections exceeding RIECs in Parcel E-2 groundwater occur in well IR04MW36A, located in the East Adjacent Area. The extent of arsenic concentrations exceeding RIECs in Parcel E-2 groundwater is localized; however, due to the persistence of the elevated concentrations in IR04MW36A, the conservative methodology applied to the risk calculations causes arsenic to be one of the most significant risk drivers, potentially leading to biased, yet conservative risk assessment results.
- Metals concentrations in groundwater contribute significantly to noncancer risk in the groundwater exposure from domestic use evaluation. Ambient concentrations of numerous metals in A-aquifer groundwater are known to exceed drinking water standards. Thus, inclusion of the metals data for the A-aquifer presumably contributes to the calculated risk associated with iron and thallium. An incremental analysis was not performed; therefore, the incremental risk contribution of metals in A-aquifer groundwater potentially related to Parcel E-2 site activities is unknown.

A summary of uncertainties for the HHRA is provided in Appendix K (Table K-17).

8.5.2.3. Ecological Risk Assessment for Groundwater

A screening-level assessment of ecological risk to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2 is provided in Appendix M. Chemical concentrations in groundwater were screened against the assigned aquatic evaluation criteria, mainly comprised of saltwater aquatic criteria, to identify COPECs for surface water quality. Site-specific data for select COPECs were then evaluated against trigger levels, consistent with the methods used in recent FS reports at other HPS parcels, to further confirm if the COPECs needed to be addressed in remedial alternatives.

Based on concentrations exceeding trigger levels (as adjusted based on HGALs), the following chemicals (or groups of chemicals) pose a potential threat to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2:

- Metals: copper, lead, and zinc;
- Anions: un-ionized ammonia, sulfide, and cyanide;
- Total PCBs: sum of detected concentrations of all Aroclor compounds; and
- Total TPH: sum of detected concentrations of all TPH ranges (gasoline-range, diesel-range, and motor-oil range).

Figure 7-6 shows the locations where groundwater concentrations exceeded their respective trigger levels. Table 7-18 summarizes the specific COPECs at the locations identified in Figure 7-6.

8.5.3. Conclusions for Groundwater

The nature and extent evaluation identified several data gaps that will be resolved by continuing the groundwater monitoring program. Two of the three A-aquifer monitoring wells abandoned during the removal action at the PCB Hot Spot Area (IR01MWI-3 and IR01MW43A) were replaced and sampled, beginning in September 2007, to assess potential reductions in chemical concentrations. Data collected from the replacement wells suggest that attenuation is occurring. The third well, abandoned during the removal action at the PCB Hot Spot Area (IR01MW44A), was replaced in April 2009. Although data from the replacement well (IR01MW66A) were not available for incorporation in this RI/FS Report, results of samples from nearby temporary wells, installed during the 2008 data gaps investigation, suggest that attenuation is also occurring at this area. The three replacement wells at this area continue to be monitored, and the monitoring data will be evaluated in the RD to determine the degree to which attenuation is occurring at this area.

Results of the HHRA showed potential risk to humans, for both construction worker trench exposure and domestic use exposure. In addition, the SLERA performed for groundwater identified numerous COPECs that pose a potential threat to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2. Groundwater areas of concern are located near the Parcel E-2 shoreline and are shown on Figure 8-3.

These findings demonstrate that both A- and B-aquifer groundwater throughout Parcel E-2 should be considered during remedial alternative development and analysis. This should include, at a minimum, examination of long-term groundwater monitoring and institutional controls. Evaluation of active remedial options (such as containment or source removal) may also be prudent for areas of concern identified near the Parcel E-2 shoreline, if deemed necessary following consideration of the RAOs and analysis of ARARs.

8.6. SURFACE WATER

Potential exposure of wildlife to unacceptable chemical concentrations in surface water runoff is monitored in accordance with a SWDMP that was originally published in 2003 (TtEMI, 2003c). Results of the Parcel E-2 stormwater program are summarized on an annual basis and include a comparison of surface water data with aquatic water quality criteria. Results to date indicate no incidents of noncompliance at Parcel E-2 except in isolated locations where BMPs require modification to better control erosion and sediment transport from neighboring properties (TtEMI, 2004d; AFA and EEC, 2005a; EEC, 2006 and 2007; MARRS and MACTEC, 2008a, 2009a, and 2010). The ongoing maintenance of the interim cap and implementation of BMPs serves to minimize erosion from surface water runoff and mitigate potential exposure to wildlife.

The potential exists for surface water runoff to be contaminated by leaching from contaminated soil or through surface erosion. Therefore, continued management (through implementation of BMPs) and monitoring of surface water runoff should be evaluated as part of any remedial alternative that leaves contaminated soil in place.

8.7. SHORELINE SEDIMENT

Potential risks to wildlife, specifically benthic invertebrates, birds, and mammals, exposed to intertidal sediments at Parcel E-2 were evaluated in a SLERA prepared in conjunction with the Shoreline Characterization Technical Memorandum (Appendix G). Concentrations of chemicals in surface and subsurface sediment samples collected from the Shoreline Area were screened against toxicological benchmarks for invertebrates, birds, and mammals.

The shoreline SLERA concluded that concentrations of copper and lead in sediment along the Parcel E-2 shoreline are a potential source of contamination to Parcel F. In addition, benthic invertebrates, birds, and mammals are at risk from exposure to PCBs in surface sediments along the Parcel E-2 shoreline.

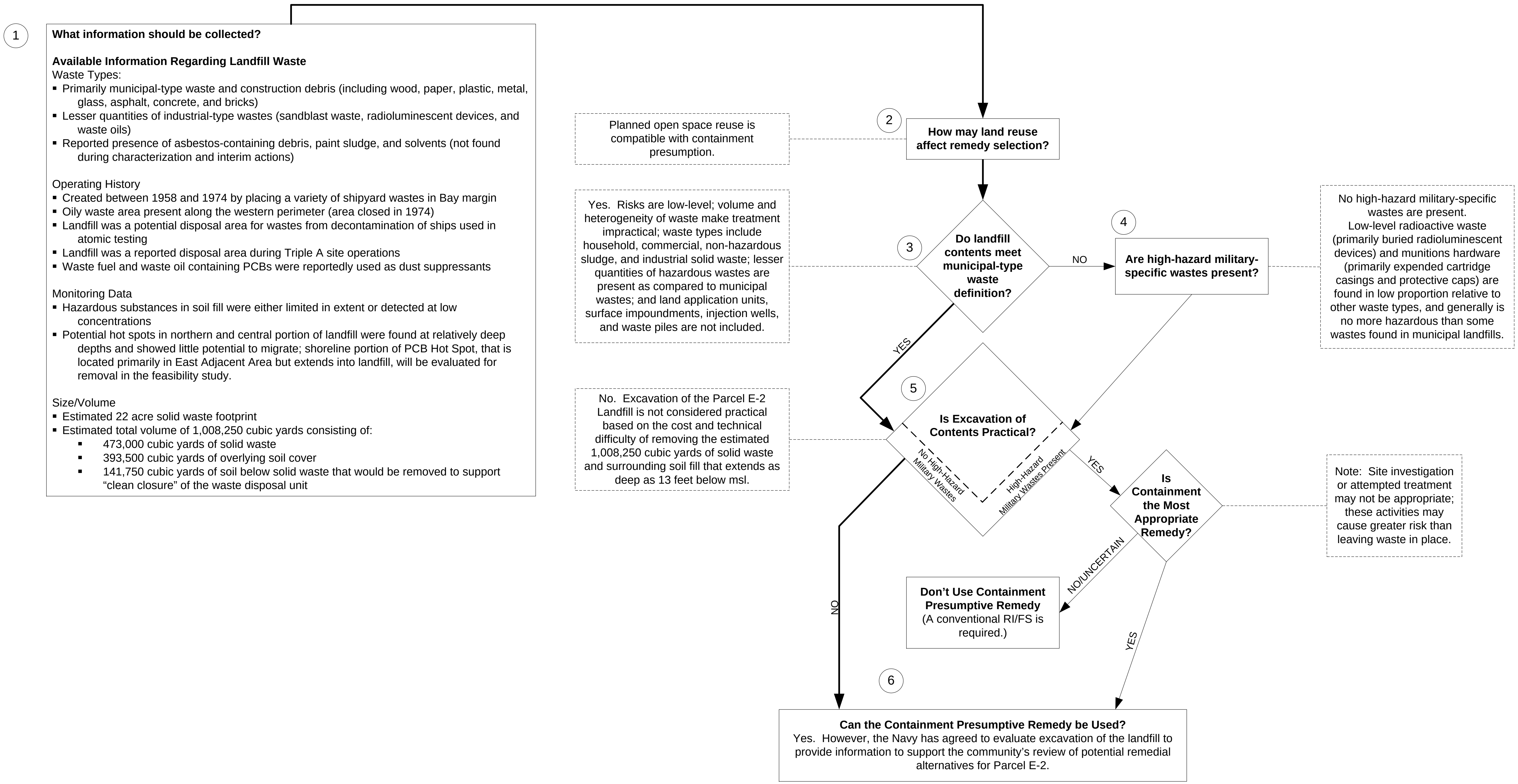
Source control measures are warranted along the Parcel E-2 shoreline, particularly in the Metal Slag Area of the Panhandle Area and the Landfill Area, to control potential releases of copper and lead to Parcel F. In addition, ecological risk to benthic invertebrates, birds, and mammals in the shoreline warrants the evaluation of remedial alternatives for intertidal sediments along the entire Parcel E-2 shoreline.

8.8. SUMMARY OF CONCLUSIONS

Parcel E-2 has been adequately characterized to support the development of a focused set of remedial alternatives, as described in Section 1.4. The conclusion that adequate data exist, despite the known data gaps at the site, is consistent with EPA RI/FS guidance. Specifically, EPA RI/FS guidance states that "the objective of the RI/FS process is not the unattainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site" (EPA, 1988a).

Based on the nature and extent evaluation, the identified exposure pathways based on the conceptual site model, and the risk assessment results, the following media and affected areas pose potential threats to human health and the environment and will undergo remedial option analysis in the FS: (1) solid waste and soil in the Landfill Area, (2) landfill gas, (3) soil and isolated solid waste in the Panhandle and East Adjacent Areas, (4) groundwater, (5) surface water runoff, and (6) shoreline sediment.

Figures



Notes:

msl	mean sea level
PCB	Polychlorinated Biphenyl
RI/FS	Remedial Investigation / Feasibility Study
→	Selected Decision Path

Source:
EPA. 1996. “Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills.” OSWER Directive 9355.0-67FS. EPA/540/F-96/020. December.

ERRG Engineering/Remediation Resources Group, Inc.

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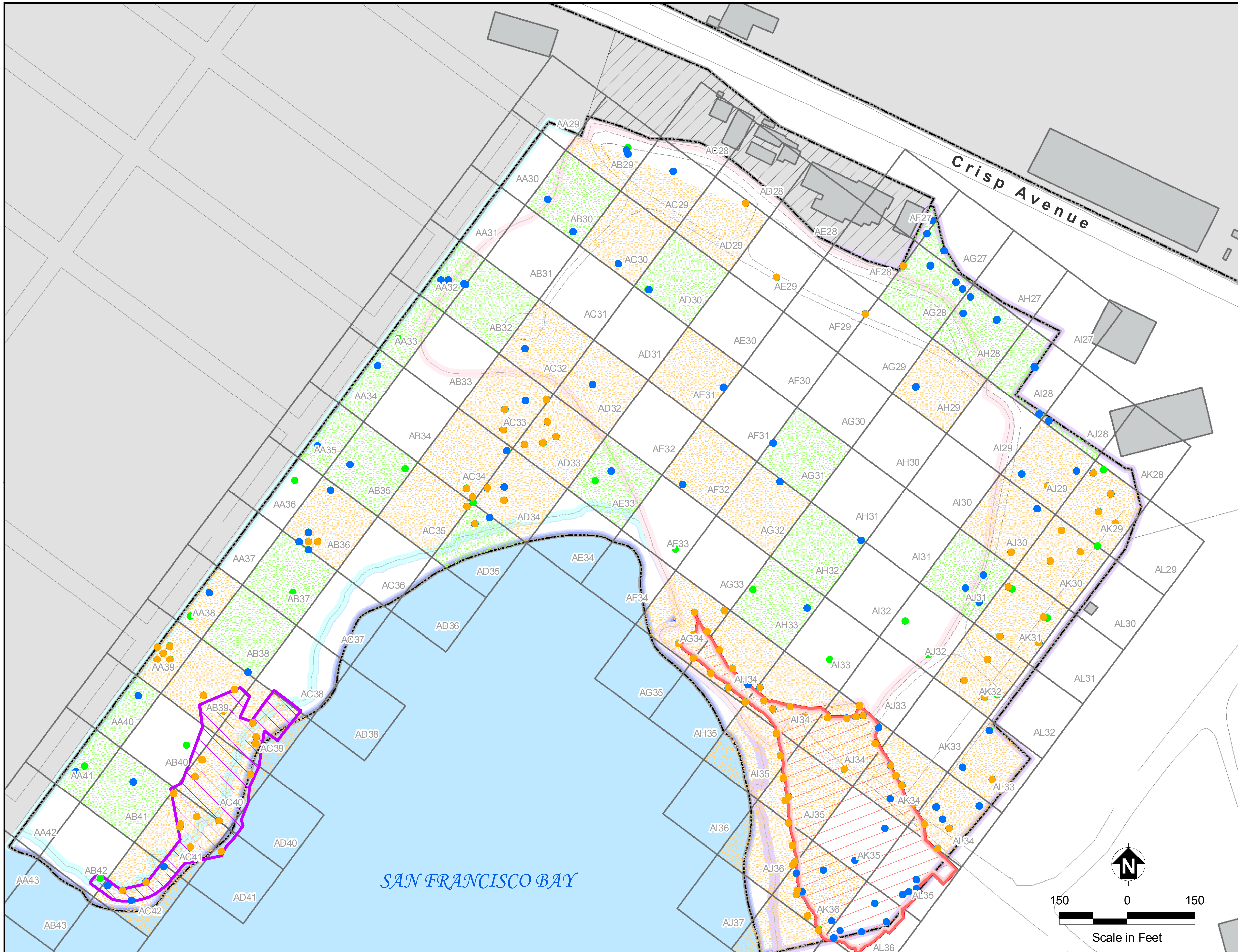
FIGURE 8-1
APPLICATION OF CONTAINMENT PRESUMPTIVE REMEDY

Remedial Investigation/Feasibility Study for Parcel E-2

P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\Graphics\Figure 8-1 Application of Containment Presumptive Remedy.vsd



Human Health Evaluation

- Risk Exceeds One or More Threshold Criteria*
- Risk Does Not Exceed One or More Threshold Criteria*
- No Data

Ecological Evaluation

- Not Analyzed
- Analyte Not Detected
- Concentration ≤ PSC
- Concentration > PSC
- PCB Hot Spot Area (2007 excavation limit)[a]
- Metal Slag Area (2007 excavation limit)[a]
- Road
- Gravel Road
- Parcel Boundary
- Building
- UCSF Compound
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Shoreline Area
- San Francisco Bay
- Non-Navy Property

Notes:

[a] Post- excavation boundaries in PCB Hot Spot Area and Metal Slag Area are consistent with information presented in final removal action completion reports (Tetra Tech EC Inc., 2007a and 2007b).

Results are only shown for locations where results have exceeded the PSC.

PCB = polychlorinated biphenyls
PSC = protective soil concentration
UCSF = University of California, San Francisco

* Human health risk based on incremental risk for recreational use scenario; complete results and threshold criteria (for cancer/noncancer risk and lead exposure) are specified on Figure 7-2.

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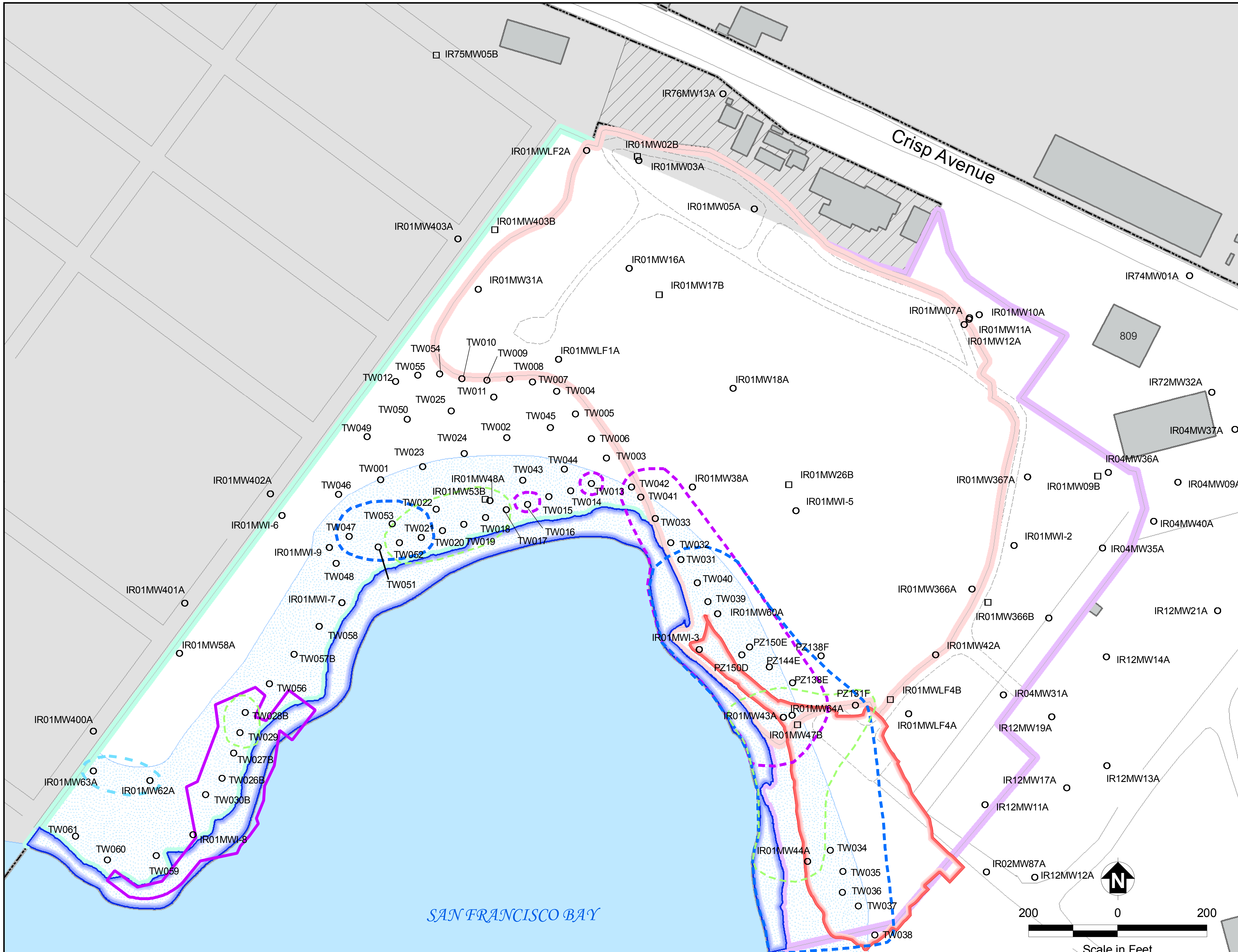
FIGURE 8-2

SOIL AREAS OF CONCERN

Remedial Investigation/Feasibility Study for Parcel E-2

P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\SLERA\Soil Areas of Concern.mxd



A-aquifer Well
B-aquifer Well
Shoreline Area
Landfill Area
Panhandle Area
East Adjacent Area
Tidal Influence Zone
Road
Gravel Road
Parcel Boundary
Building
UCSF Compound
San Francisco Bay
Non-Navy Property

Removal Actions

Metal Slag Area (2007 excavation limit)[a]
PCB Hot Spot Area (2007 excavation limit)[a]

Estimated areas where COPECs may be migrating to the bay at concentrations exceeding aquatic evaluation criteria:

Anions
Metals
Total PCBs
Total TPH

Notes:

[a] Post- excavation boundaries in PCB Hot Spot Area and Metal Slag Area are consistent with information presented in final removal action completion reports (Tetra Tech EC Inc., 2007a and 2007b).

The tidal influence study was conducted May 20 to June 3, 2002. (Tetra Tech EM Inc., 2004a.)

COPECs = Chemicals Of Potential Ecological Concern
PCBs = Polychlorinated biphenyls
TPH = Total Petroleum Hydrocarbons
UCSF = University of California, San Francisco

Reference

Tetra Tech EM Inc. 2004a. "Revised Final Parcel E Groundwater Summary Report, Phase III Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California." October 17.

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FIGURE 8-3

GROUNDWATER AREAS OF CONCERN

Remedial Investigation/Feasibility Study for Parcel E-2

P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Section 4\Water\Aquatic\Areas of Concern.mxd

Section 9. Remedial Action Objectives

This section identifies RAOs for contaminated media at Parcel E-2, as identified in Section 8, that will satisfy the remedial action goals for protecting human health and the environment. RAOs are medium-specific goals that specify (1) the COCs, (2) the exposure route(s) and receptor(s), and (3) an acceptable chemical concentration or range of concentrations for each exposure pathway and medium. RAOs include both an exposure pathway and a chemical concentration for a given medium because protectiveness can be achieved by either limiting (or eliminating) the pathway or by reducing (or eliminating) the chemical.

The RAO evaluation for Parcel E-2 is based on information from the RI field activities, subsequent environmental investigations, and risk assessments for human health and the environment. The NCP details the expectations for remedy selection in 40 CFR § 300.430 (a)(1)(iii). These expectations were used to evaluate RAOs for Parcel E-2. In addition, the U.S. Department of Defense integrates these NCP expectations with BRAC program objectives for expediting the transfer of U.S. Department of Defense property for reuse and development.

An important component of developing RAOs is the determination of future land use. According to EPA's land use directive (EPA, 1995a), RAOs "...should reflect the reasonably anticipated future land use or uses...," thereby allowing for the development of "alternatives that would achieve cleanup levels associated with the reasonably anticipated future land use..." of the site. The EPA land use directive states that "in cases where future land use is relatively certain, the RAOs generally should reflect this land use..." and "...need not include alternative land use scenarios..." (EPA, 1995a).

RAOs developed for Parcel E-2 are based on the city's reasonably anticipated future use of the property as described in the HHRA. According to the 2010 amended Redevelopment Plan, most of the planned reuse for Parcel E-2 is open space; however, a small area (about 0.42 acres) in the East Adjacent Area is designated as part of the Shipyard South Multi-Use District, which includes potential recreational, industrial, and residential reuse (SFRA, 2010). As discussed in Section 1.8 and documented in the previous versions of the RI/FS Report published in 2007 and 2009, land uses other than open space were not anticipated prior to publication of the 2010 amended Redevelopment Plan. Based on the risk assessment results discussed in Section 7.1.2.1, contamination is present in the 0.42-acre area at concentrations that pose an unacceptable risk for future recreational users, and a risk evaluation using more conservative exposure factors associated with potential residential reuse would have reached the same conclusion. Accordingly, this report evaluates remedial actions to address this potential risk.

The following subsections discuss the RAOs for (1) solid waste, soil, and sediment; (2) landfill gas; (3) groundwater; and (4) surface water.

9.1. REMEDIAL ACTION OBJECTIVES FOR SOLID WASTE, SOIL, AND SEDIMENT

Separate RAOs were developed for humans and wildlife. For humans, the HHRA for Parcel E-2 evaluated risk associated with the reasonably anticipated reuse (open space). The exposure scenario applicable to open space reuse is recreational. In addition, an exposure scenario for construction workers was evaluated for Parcel E-2. According to the HHRA, the primary exposure pathways to humans from contaminated soil, under both the recreational user and construction worker scenarios, are through ingestion, dermal contact, and inhalation. For terrestrial wildlife, the onshore SLERA for Parcel E-2 evaluated risk associated with direct exposure to soil at 0 to 3 feet bgs. For aquatic wildlife, the shoreline SLERA evaluated risk associated with direct exposure to intertidal sediment in the Shoreline Area (0 to 2.5 feet bgs).

9.1.1. Chemicals of Concern and Chemicals of Ecological Concern in Solid Waste, Soil, and Sediment

COCs and COECs and associated remediation goals for each exposure scenario are summarized in the table below. The COCs, COECs, and remediation goals form the basis for the RAOs presented in Section 9.1.2 by providing contaminant-specific concentrations that are protective under the given exposure scenario.

Exposure Scenario	COCs/COECs	Remediation Goal (mg/kg)	COCs/COECs	Remediation Goal (mg/kg)
Recreational User[a]	Antimony	270	Benzo(b)fluoranthene	1.3
	Aroclor-1242	0.74	Benzo(k)fluoranthene	1.3
	Aroclor-1248	0.74	Dieldrin	0.12
	Aroclor-1254	0.74	Heptachlor epoxide	0.21
	Aroclor-1260	0.74	Indeno(1,2,3-cd)pyrene	1.3
	Arsenic[b]	11.1	Lead	155
	Benzo(a)anthracene	1.3	Total PCBs (non-dioxin)	0.74
	Benzo(a)pyrene	0.33		
Construction Worker[c]	4,4'-DDT	45	Copper	11,000
	Antimony	120	Dibenz(a,h)anthracene	1.1
	Aroclor-1016	7.4	Dieldrin	0.57
	Aroclor-1242	2.1	Dioxin (TEQ)	0.000023
	Aroclor-1248	2.1	Heptachlor epoxide	1
	Aroclor-1254	2.1	Indeno(1,2,3-cd)pyrene	6.5
	Aroclor-1260	2.1	Iron	93,000
	Arsenic[b]	11.1	Lead	800
	Benzo(a)anthracene	6.5	Manganese	6,900

Exposure Scenario	COCs/COECs	Remediation Goal (mg/kg)	COCs/COECs	Remediation Goal (mg/kg)
	Benzo(a)pyrene	0.65	Naphthalene	75
	Benzo(b)fluoranthene	6.5	Total PCBs (non-dioxin)	2.1
	Benzo(k)fluoranthene	6.5	Vanadium	310
	Cadmium	150	Total TPH[d]	3,500

Exposure Scenario	COCs/COECs	Remediation Goal (mg/kg)	COCs/COECs	Remediation Goal (mg/kg)
Terrestrial Wildlife	Cadmium	4.2	Vanadium[b]	117
	Copper	470	Zinc	719
	Lead	197	Total DDT	3.53
	Manganese	2,433	Total PCBs	37
	Mercury	1.0	Total HMW PAHs	231
	Nickel	1,941		
Aquatic Wildlife	Antimony	25	Zinc	410
	Copper	270	Total DDTs[f]	0.046
	Lead	218	Dieldrin	0.008
	Mercury	0.71	Endrin	0.045
	Nickel[e]	112	Total PCBs	0.18

Notes:

a The remediation goals for this exposure scenario were derived from risk-based concentrations, ambient levels, and practical quantitation limits presented in Table 7-13. COCs identified for this exposure scenario are based on the reasonably anticipated reuse for Parcel E-2 as open space; see Table 7-1 for a list of complete exposure pathways associated with this scenario.

b The remediation goal is equal to the HPAL (PRC, 1995a).

c The remediation goals for this exposure scenario were derived from risk-based concentrations, ambient levels, and practical quantitation limits presented in Table 7-13. The construction worker exposure scenario is not associated with a specific planned reuse for Parcel E-2; see Table 7-1 for a list of complete exposure pathways associated with this scenario.

d The TPH remediation goal is based on the HPS petroleum source criteria (Shaw, 2007).

e The remediation goals are based on the San Francisco Bay ambient values (RWQCB, 1998).

f The remediation goal includes concentrations of DDD and DDE.

9.1.2. Solid Waste, Soil, and Sediment Remedial Action Objectives for the Protection of Human Health and the Environment

By relating the above remediation goals to specific exposure pathways, the RAOs for solid waste, soil, and sediment at Parcel E-2 for the protection of human health and the environment are:

1. Prevent human exposure to inorganic and organic chemicals at concentrations greater than remediation goals (developed in the HHRA in Table 7-13) for the following exposure pathways:
   - Ingestion of, outdoor inhalation of, and dermal exposure to solid waste, soil, or sediment from 0 to 2 feet bgs by recreational users throughout Parcel E-2.
   - Ingestion of, outdoor air inhalation of, and dermal exposure to solid waste, soil, or sediment from 0 to 10 feet bgs by construction workers throughout Parcel E-2.
2. Prevent ecological exposure to concentrations of inorganic and organic chemicals in solid waste or soil greater than remediation goals (identified in the onshore SLERA in Appendix L) from 0 to 3 feet bgs by terrestrial wildlife throughout Parcel E-2.
3. Prevent ecological exposure to concentrations of inorganic and organic chemicals in intertidal sediment greater than remediation goals (identified in the shoreline SLERA in Appendix G) from 0 to 2.5 feet bgs by aquatic wildlife throughout the Shoreline Area.

9.2. LANDFILL GAS REMEDIAL ACTION OBJECTIVES

Landfill gas RAOs address both methane gas and NMOCs present at the Parcel E-2 Landfill. Methane gas emitted from the landfill may migrate off site and could accumulate in structures and confined spaces to create an explosive or oxygen-deficient atmosphere. NMOCs could cause unacceptable risk to human health and the environment. Previous risk assessments were performed using the Johnson and Ettinger vapor intrusion model (EPA, 2003a), and resulted in the development of an NMOC action level of 500 ppmv for subsurface gas measurements (discussed in Section 8.3.3) that is considered protective of human health.

27 CCR § 20921(a) sets limits for both methane gas and NMOCs at the Parcel E-2 Landfill, which are the guiding principles for development of the RAOs for landfill gas. The RAOs for landfill gas are summarized below.

1. Control methane concentrations to 5 percent (by volume in air) or less at subsurface points of compliance.
2. Control methane concentrations to 1.25 percent (by volume in air) or less in on-site structures ("on-site" for this RI/FS Report is defined as any area within the subsurface points of compliance for landfill gas).
3. Prevent exposure to NMOCs at concentrations greater than 500 ppmv at the subsurface points of compliance.
4. Prevent exposure to NMOCs at concentrations greater than 5 ppmv above background levels in the breathing zone of on-site workers and visitors.

9.3. GROUNDWATER REMEDIAL ACTION OBJECTIVES

RAOs for Parcel E-2 groundwater were developed based on (1) human health risks through the domestic use exposure pathway from the B-aquifer; (2) health risks to construction workers from dermal contact and inhalation of volatilized compounds emitted from the A-aquifer; and (3) potential migration of COPECs that could result in surface water concentrations above aquatic water quality criteria. With the exception of total TPH, the identified chemicals in groundwater that may pose a risk to aquatic wildlife in the Bay (Appendix M) are considered COPECs (that is, of chemicals of potential ecological concern) given the conservative nature of the risk analysis performed for that pathway. As such, groundwater remediation goals have not been developed for these COPECs. However, these groundwater COPECs are considered under the remedial alternatives developed and analyzed in the FS. The remedial alternatives to be evaluated in the FS will include source removal, containment, and monitoring; these remediation technologies are considered adequate to address the potential risk to aquatic wildlife in the Bay.

In addition, development of groundwater monitoring criteria for COPECs is problematic at this stage due to the conservative nature of the screening-level assessment of potential risks to aquatic wildlife. The aquatic evaluation criteria used in Appendix M, which are based on standards for aquatic wildlife in the Bay, apply to the surface water at the interface of the A-aquifer groundwater and do not apply to *in situ* A-aquifer groundwater at Parcel E-2. Development of specific monitoring criteria for A-aquifer groundwater that address the potential risk to aquatic wildlife in the Bay requires more refined fate and transport modeling to more rigorously assess the groundwater to surface water transport mechanism. Such refined modeling is not considered necessary to proceed with the FS because, as stated above, the anticipated remedial technologies (source removal, containment, and monitoring) will adequately address the potential risk to aquatic wildlife in the Bay. The need to refine the fate and transport modeling and develop specific monitoring criteria for A-aquifer groundwater will be evaluated further in the RD.

9.3.1. Chemicals of Concern and Chemicals of Ecological Concern in Groundwater

COCs and COECs and their associated remediation goals for each exposure scenario are summarized in the following table. These COCs, COECs, COPECs, and remediation goals form the basis for the RAOs presented in Sections 9.3.2 and 9.3.3.

Exposure Scenario	COCs/COECs	Remediation Goal (µg/L)	COCs/COECs	Remediation Goal (µg/L)
Domestic Use[a]	1,1-Dichloroethane	5	Chloroform	80
	1,2,3-Trichloropropane	1	Chromium VI	109
	1,2-Dichloroethane	0.5	Chrysene	0.56
	1,4-Dichlorobenzene	5	Dibenz(a,h)anthracene	0.2
	4-Nitrophenol	3.4	Dieldrin	0.02
	Aroclor-1016	0.5	Heptachlor	0.01
	Aroclor-1242	0.5	Heptachlor epoxide	0.01
	Aroclor-1254	0.5	Heptachlor epoxide A	0.01
	Aroclor-1260	0.5	Heptachlor epoxide B	0.01
	Arsenic	10	Indeno(1,2,3-cd)pyrene	0.2
	Benzene	1	Iron	10,950
	Benzo(a)anthracene	0.2	Lead	15
	Benzo(a)pyrene	0.2	Methylene Chloride	5
	Benzo(b)fluoranthene	0.2	Naphthalene	1
	Benzo(k)fluoranthene	0.2	Tetrachloroethene	5
	Beta-BHC	0.05	Thallium	2
	Bis(2-ethylhexyl)phthalate	10	Trichloroethene	5
	Carbon tetrachloride	0.5	Vinyl chloride	0.5
Construction Worker[b]	Benzo(a)anthracene	0.67	Dibenz(a,h)anthracene	0.05
	Benzo(a)pyrene	0.05	Indeno(1,2,3-cd)pyrene	0.31
	Benzo(b)fluoranthene	0.45	Lead	15
	Benzo(k)fluoranthene	0.45		
Aquatic Wildlife[c]	Total TPH	1,400-20,000[d]		

Notes:

a The remediation goals for this exposure scenario were derived from risk-based concentrations, MCLs, ambient levels, and practical quantitation limits presented in Table 7-15. Data from the A-aquifer were also used to identify COCs in the domestic use evaluation to account for potential communication between the A- and Upper B-aquifers in some areas of Parcel E-2; see Table 7-1 for a list of complete exposure pathways associated with this scenario.

b The remediation goals for this exposure scenario were derived from risk-based concentrations, ambient levels, and practical quantitation limits presented in Table 7-14. The construction worker exposure scenario is not associated with a specific planned reuse for Parcel E-2; see Table 7-1 for a list of complete exposure pathways associated with this scenario.

c COECs cannot be defined and groundwater monitoring criteria cannot be established without refined fate and transport modeling. The following COPECs were identified during a trigger level analysis (see Appendix M): un-ionized ammonia, sulfide, copper, lead, zinc, total PCBs, and total DDT.

d Total TPH aquatic criteria assigned as a function of distance from shoreline; the source of these criteria is the Hunters Point petroleum source criteria (Shaw, 2007).

9.3.2. Groundwater Remedial Action Objectives for the Protection of Human Health

The A-aquifer is not considered a domestic use aquifer; as a result, exposure to COCs via domestic use of groundwater is not considered a complete pathway (see Section 2.2.6). The B-aquifer was assessed for potential domestic use exposure pathways (see Section 2.2.6 and Appendix I) and determined to pose a potential risk to human health. The RAOs summarized below will be applied to protect human health for the domestic use exposure pathway.

1. Prevent exposure to groundwater that may contain COCs at concentrations greater than remediation goals (developed in the HHRA in Table 7-15) through the domestic use pathway.
2. Prevent or minimize migration of B-aquifer groundwater that may contain COCs at concentrations greater than remediation goals (developed in the HHRA in Table 7-15) beyond the compliance boundary (defined in Appendix N, Section N2.1.1).

Exposure to benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and lead in groundwater presents a potential unacceptable risk to construction workers at Parcel E-2. As a result, the following RAO will be applied to protect human health for the construction worker exposure pathway:

1. Prevent or minimize dermal exposure to and vapor inhalation from A-aquifer groundwater containing COCs at concentrations greater than remediation goals (developed in the HHRA in Table 7-14) by construction workers.

9.3.3. Groundwater Remedial Action Objectives for the Protection of Wildlife

Concentrations of anions, metals, PCBs, and total TPH are present in shoreline wells at concentrations that may pose a risk to aquatic wildlife in San Francisco Bay. The RAOs summarized below were developed to address the potential migration of contaminated groundwater in the A-aquifer into the bay.

1. Prevent or minimize migration COPECs (listed in Table 7-6) to prevent discharge that would result in concentrations greater than the corresponding water quality criteria for aquatic wildlife.
2. Prevent or minimize migration of A-aquifer groundwater containing total TPH concentrations greater than the remediation goal (where commingled with CERCLA substances) into San Francisco Bay.

9.4. SURFACE WATER REMEDIAL ACTION OBJECTIVES

Surface water RAOs address point discharges from Parcel E-2 into San Francisco Bay. Surface water is monitored for water quality and toxic pollutant parameters in accordance with the NPDES General Permit for HPS. The following RAO was developed to address the potential migration of contaminated soil via surface water erosion into the bay:

1. Prevent or minimize migration of surface water that may contain COPECs at concentrations greater than water quality criteria for aquatic life (listed in current SWDMP) into San Francisco Bay.

9.5. SUMMARY OF REMEDIAL ACTION OBJECTIVES

The following table summarizes the RAOs for each medium.

Medium / Receptor	Goal
Waste, Soil, and Sediment / Humans	Prevent exposure to organic and inorganic chemicals at concentrations greater than the remediation goals in (1) solid waste, soil, or sediment from 0 to 2 feet bgs by recreational users; or (2) solid waste, soil, or sediment from 0 to 10 feet bgs by construction workers.
Waste, Soil, and Sediment / Wildlife	Prevent exposure of wildlife to organic and inorganic chemicals in solid waste or soil at concentrations greater than the remediation goals from 0 to 3 feet bgs throughout Parcel E-2. Prevent exposure of wildlife to organic and inorganic chemicals in intertidal sediment at concentrations greater than the remediation goals from 0 to 2.5 feet bgs throughout the Shoreline Area.
Landfill Gas	Control methane concentrations to (1) 5 percent (by volume in air) or less at subsurface points of compliance; and (2) 1.25 percent (by volume in air) or less in on-site structures. Prevent exposure to NMOCs at concentrations (1) greater than 500 ppmv at the subsurface points of compliance; and (2) greater than 5 ppmv above background levels in the breathing zone of on-site workers and visitors.
Groundwater / Humans	Prevent exposure to groundwater that may contain COCs at concentrations greater than the remediation goals through the domestic use pathway. Prevent or minimize migration of B-aquifer groundwater that may contain COCs at concentrations greater than the remediation goals beyond the compliance boundary. Prevent or minimize dermal contact to and vapor inhalation from A-aquifer groundwater containing COCs at concentrations greater than remediation goals by construction workers.
Groundwater / Wildlife	Prevent or minimize migration of COPECs to prevent discharge that would result in concentrations greater than the corresponding water quality criteria for aquatic wildlife. Prevent or minimize migration of A-aquifer and B-aquifer groundwater containing total TPH concentrations greater than the remediation goal (where commingled with CERCLA substances) into San Francisco Bay.
Surface Water / Wildlife	Prevent or minimize migration of surface water that may contain COECs at concentrations greater than water quality criteria for aquatic wildlife into San Francisco Bay.

Section 10. Potential Applicable or Relevant and Appropriate Requirements

CERCLA § 121(d)(l) states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any ARARs, which include environmental regulations, standards, criteria, or limitations promulgated under federal or more stringent state laws. An ARAR may be either applicable, or relevant and appropriate, but not both. The NCP (40 CFR § 300.5) definition of applicable, and relevant and appropriate is presented below.

> *Applicable requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.*

> *Relevant and appropriate requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.*

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be (1) a standard, requirement, criterion, or limitation under a state environmental or facility siting law; (2) promulgated (of general applicability and legally enforceable); (3) substantive (not procedural or administrative); (4) more stringent than the federal requirement; (5) identified by the state in a timely manner; and (6) consistently applied.

CERCLA § 121(e) exempts any response action conducted entirely on site from having to obtain a federal, state, or local permit when the action is carried out in compliance with § 121. In general, on-site actions need only comply with the substantive aspects of ARARs, not with the corresponding administrative procedures, such as administrative reviews and recording and record-keeping requirements. Off-site actions must comply with all legally applicable requirements, both substantive and administrative.

ARAR identification considers a number of site-specific factors, including potential remedial actions, compounds at the site, site physical characteristics, and the site location. ARARs are usually divided into three categories: chemical-specific, location-specific, and action-specific.

EPA guidance (EPA, 1988a) recommends that the lead federal agency consult with the state when identifying state ARARs for remedial actions. CERCLA and NCP requirements (40 CFR § 300.515) for remedial actions state that the lead federal agency will request that the state identify chemical- and location-specific state ARARs after completion of site characterization. The requirements also provide that the lead federal agency request identification of all categories of state ARARs (chemical-, location-, and action-specific) upon completion of identification of remedial alternatives for detailed analysis. Identification of potential state ARARs was initiated through Navy requests to the DTSC, RWQCB, and San Francisco Bay Conservation and Development Commission.

This section addresses potential ARARs for CERCLA hazardous substances, with the exception of radionuclides. Potential ARARs for radiological contamination will be addressed in the radiological addendum to this RI/FS Report. Both chemical and radiological contaminants will then be addressed together in the proposed plan and ROD.

This section summarizes potential federal and state of California ARARs for Parcel E-2. Section 10.1 discusses potential chemical-specific ARARs, Section 10.2 discusses potential location-specific ARARs, and Section 10.3 discusses potential action-specific ARARs. Appendix N presents the complete ARARs evaluation.

10.1. POTENTIAL CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Chemical-specific ARARs are health- or risk-based numerical values or methods that, when applied to site-specific conditions, result in the establishment of numerical cleanup values. These values are protective of human health and the environment and establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment.

For Parcel E-2, the potential media of concern are groundwater, surface water, soil, sediment, solid waste, and subsurface air. This section summarizes the potential chemical specific ARARs for these media; potential chemical specific ARARs for sediment, solid waste, and subsurface air are discussed with those specified for soil (Section 10.1.3).

10.1.1. Groundwater

The regulations summarized below pertain to groundwater monitoring, which is performed at Parcel E-2 because groundwater may have been affected by the Parcel E-2 Landfill and other site operations. The substantive provisions of these requirements are identified in Section N2.1 of Appendix N and are accepted as potential ARARs.

- 40 CFR §§ 141.11 (excluding § 141.11[d][3]), 141.13, 141.15, 141.16, 141.61(a) and (c), and 141.62(b). MCLs identified in these sections are potential ARARs for the following scenarios: (1) complete clean closure involving excavation of the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which MCLs are potential federal ARARs for groundwater in the B-aquifer throughout Parcel E-2; and (2) containment of in-place waste within the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which MCLs are potential federal ARARs for groundwater in portions of the B-aquifer downgradient of the point of compliance.
- Title 22 California Code of Regulations (22 CCR) §§ 66264.94 (a)(1), (a)(3), (c), (d), and (e). This section is relevant for achieving the lowest concentration limit in the A-aquifer based on unacceptable risk from the vapor intrusion pathway. These potential ARARs pertain to the following scenarios: (1) complete clean closure involving excavation of the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which concentration limits based on unacceptable risk from the vapor intrusion pathway are potential federal ARARs for groundwater in the A-aquifer throughout Parcel E-2 (except for the small northwest portion of the A-aquifer where the Bay Mud confining unit or aquitard does not separate the A-aquifer from the uppermost B-aquifer); and (2) containment of in-place waste within the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which concentration limits based on unacceptable risk from the vapor intrusion pathway are potential federal ARARs for groundwater in portions of the A-aquifer downgradient of the point of compliance.
- California Water Code, Division 7 §§ 13241, 13243, 13263(a), 13269, and 13360. The Navy accepts the substantive provisions of these sections as enabling legislation as implemented through the beneficial uses, water quality objectives (WQOs), waste discharge requirements, and promulgated policies of the Comprehensive Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan).
- The Navy accepts the substantive provisions for groundwater relating to beneficial uses, WQOs, waste discharge requirements, and promulgated policies in Chapters 2 and 3 of the Basin Plan, which incorporates SWRCB Resolution 88-63 (SWRCB, 1988).
- SWRCB, Resolution 88-63 (SWRCB, 1988). This requirement indicates that A-aquifer groundwater at HPS is not a potential drinking water source, and that B-aquifer groundwater has a moderate potential for use as a drinking water source.
- 22 CCR, §§ 64431 and 64444. State MCLs identified in these sections are potential ARARs for the following scenarios: (1) complete clean closure involving excavation of the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which

MCLs are potential state ARARs for groundwater in the B-aquifer throughout Parcel E-2; and (2) containment of in-place waste within the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which MCLs are potential state ARARs for groundwater in portions of the B-aquifer downgradient of the point of compliance.

- 22 CCR, § 64449(a). State secondary MCLs identified in this section are potential ARARs for the following scenarios: (1) complete clean closure involving excavation of the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which MCLs are potential state ARARs for groundwater in the B-aquifer throughout Parcel E-2; and (2) containment of in-place waste within the Parcel E-2 Landfill and adjacent areas (Landfill Area, East Adjacent Area, and Panhandle Area), for which MCLs are potential state ARARs for groundwater in portions of the B-aquifer downgradient of the point of compliance.

10.1.2. Surface Water

The regulations summarized below pertain to surface water bodies at Parcel E-2 (e.g., freshwater wetlands), and the interface where A-aquifer groundwater discharges to the San Francisco Bay. The substantive provisions of these requirements are identified in Section N2.2 of Appendix N and are accepted as potential ARARs.

- 40 CFR § 131.38. These standards, known as the California Toxics Rule (CTR), are applicable surface water ARARs because surface water and groundwater discharges from Parcel E-2 to San Francisco Bay.
- Table 3-3 of the Basin Plan. The RWQCB promulgated these water quality objectives for toxic pollutants in surface water with salinities greater than 5 parts per thousand.

10.1.3. Soil

The regulations summarized below pertain to characterizing any solid waste generated during remedial actions which involve off-site disposal. The substantive provisions of these requirements are identified in Section N2.3 of Appendix N and are accepted as potential ARARs.

- 22 CCR §§ 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100. These sections define RCRA hazardous waste.
- 22 CCR §§ 66261.22(a)(3), (a)(4), 66261.24(a)(2)-(a)(8), 66261.101, 66261.3(a)(2)(C), and (a)(2)(F). These sections define non-RCRA hazardous waste.
- 27 CCR §§ 20210 and 20220. These sections define designated waste and nonhazardous waste.

In addition, the potential ARARs identified in Section N2.3 of Appendix N include requirements for subsurface methane being produced in the Parcel E-2 Landfill. The SWRCB and the California Integrated Waste Management Board (CIWMB) require that the release of methane gas from the Parcel E-2 Landfill be controlled under 27 CCR § 20921(a), which set limits for methane gas within on-site structures (1.25 percent by volume) and at the facility property boundary (5 percent by volume in air).

10.2. POTENTIAL LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section discusses potential location-specific ARARs based on various attributes of Parcel E-2's location (such as its location in a coastal zone). Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities based on site characteristics or the site's immediate environment. The location-specific ARARs applicable to Parcel E-2 are the coastal resources (Section 10.2.1), wetlands protection (Section 10.2.2), biological resources (Section 10.2.3), and cultural resources (Section 10.2.4).

10.2.1. Coastal Resources

The regulations summarized below pertain to coastal resources. Because Parcel E-2 contains coastal resources that would be affected by the proposed remedial alternatives, the substantive provisions of these requirements are identified in Section N3.1 of Appendix N and are accepted as potential ARARs.

- Coastal Zone Management Act; 16 USC § 1456(c) and Title 15 Code of Federal Regulations § 930. These sections require activities to be conducted in a manner consistent with approved state management programs. The relevant California program is outlined in the San Francisco Bay Plan (San Francisco Bay Conservation and Development Commission [BCDC], 2008).
- Clean Water Act of 1977; 33 USC § 1344. This section requires action to prohibit discharge of dredged or fill material into waters of the United States (including coastal resources) without a permit.
- McAteer-Petris Act; 14 CCR §§ 10110 through 11990. These sections require that activities within San Francisco Bay and the shoreline (100 feet landward from the shoreline) be conducted in accordance with the policies of the San Francisco Bay Plan (BCDC, 2008).

10.2.2. Wetlands Protection

The regulations summarized below pertain to wetlands protection. Because Parcel E-2 contains wetland areas that would be affected by the proposed remedial alternatives, the substantive provisions of these requirements are identified in Section N3.2 of Appendix N and are accepted as potential ARARs.

- Executive Order 11990, Protection of Wetlands (which is cited at 33 CFR § 320.4[b][1]). This executive order requires action to minimize the destruction, loss, or degradation of wetlands, or to mitigate and restore wetlands if any are destroyed or impaired.
- Clean Water Act of 1977; 33 USC§ 1344. This section requires action to prohibit discharge of dredged or fill material into waters of the United States (including certain wetlands) without a permit.

10.2.3. Biological Resources

The regulations summarized below pertain to biological resources. The substantive provisions of these requirements are identified in Section N3.3 of Appendix N and are accepted as potential ARARs.

- Migratory Bird Treaty Act of 1972; 16 USC § 703. This act prohibits at any time, using any means or manner, the pursuit, hunting, capturing, and killing, or the attempt to take, capture or kill any migratory bird.
- California Fish and Game Code § 2080. This section prohibits the taking of any endangered or threatened species.
- California Fish and Game Code § 3511. This section prohibits the taking of fully-protected birds.
- California Fish and Game Code §§ 5650(a), (b), and (c). These sections prohibit the passage of enumerated substances or materials into waters of the state deleterious to fish, plant life, or birds.

10.2.4. Cultural Resources

Section 106 of the National Historic Preservation Act (16 USC § 470–470x-6), and its accompanying implementing regulations in 36 CFR Part 800, require that CERCLA remedial actions take into account the effects of remedial activities on any historic properties included on or eligible for inclusion on the National Register. Because a sensitive archaeological area (potential shellmound site) has been identified in the northwest portion of Parcel E-2 (Navy, Advisory Council on Historic Preservation, and State Historic Preservation Office, 2000), the substantive provisions of these requirements are identified in Section N3.4 of Appendix N and are accepted as potential ARARs.

10.3. POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Potential action-specific ARARs for each of the remedial alternatives are based on GRAs required to address known or potential risk at Parcel E-2. Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities. These requirements are triggered by the particular remedial activities conducted at the site and indicate how a selected remedial alternative should be achieved. Remedial alternatives for Parcel E-2 include containment (Section 10.3.1), construction and grading (Section 10.3.2), shoreline construction (Section 10.3.3), landfill gas monitoring and control (Section 10.3.4), groundwater monitoring (Section 10.3.5), surface water monitoring and management (Section 10.3.6), institutional controls (Section 10.3.7), leachate collection and control (Section 10.3.8), and excavation and off-site disposal (Section 10.3.9).

10.3.1. Action-Specific Applicable or Relevant and Appropriate Requirements for Containment

The following regulations pertain to alternatives that would contain waste in place. The substantive provisions of these requirements are identified in Section N4.3.1 of Appendix N and are accepted as potential ARARs.

- Compaction: 22 CCR § 66264.228(e)(1). This section requires that, if waste is to remain in a unit, the unit shall be compacted before any portion of the final cover is installed.
- Post-closure Water Entry: 22 CCR § 66264.310(a)(1). This section requires that the final cover be designed to prevent the downward entry of water into the closed landfill throughout a period of at least 100 years. The Navy has determined that the substantive provisions of 22 CCR § 66264.310(a)(1) are relevant and appropriate for containment actions in the Landfill Area; however, this section is not relevant and appropriate for containment actions in the Panhandle, East Adjacent, and Shoreline Areas. This determination is discussed in Section N4.3.1 of Appendix N.
- Cover Seismic Requirements: 22 CCR § 66264.310(a)(5). This section requires that the final cover be designed to accommodate lateral and vertical shear forces generated by the maximum credible earthquake so that the integrity of the cover is maintained.
- Post-closure Care: 22 CCR § 66264.310(b)(1). This section requires that the integrity and effectiveness of the final cover be maintained throughout the post-closure period.
- Benchmark Maintenance: 22 CCR § 66264.310(b)(5). This section requires that surveyed benchmarks be protected and maintained throughout the post-closure period.
- Capping permeability: 27 CCR §§ 20320(c) and (d). This section requires that hydraulic conductivities be evaluated primarily through laboratory methods, and that they be confirmed by appropriate field testing. The Navy has determined that the substantive provisions of 27 CCR §§ 20320(c) and (d) are relevant and appropriate for containment actions in the Landfill Area; however, these sections are not relevant and appropriate for containment actions in the Panhandle, East Adjacent, and Shoreline Areas. This determination is discussed in Section N4.3.1 of Appendix N.
- Erosion Control: 27 CCR §§ 20365(c) and (d), and 21090(c)(4). This section requires that diversion and drainage facilities be designed, constructed, and maintained to accommodate the anticipated volume of site precipitation and peak flows. In addition, erosion and related damage of the final cover due to drainage must be prevented throughout the post-closure maintenance period.
- Post-closure care period: 27 CCR § 20950(a). This section requires that the post-closure maintenance period shall extend as long as the wastes pose a threat to water quality.
- Foundation layer: 27 CCR § 21090(a)(1). This section requires that closed landfills be provided with not less than 2 feet of appropriate materials as a foundation layer for the final cover. These materials may be soil, contaminated soil, incinerator ash, or other waste materials, provided that such materials have appropriate engineering properties to be used for a foundation layer. The foundation layer shall be compacted to the maximum density obtainable at optimum moisture

content using methods that are in accordance with accepted civil engineering practice. A lesser thickness may be allowed for units if the differential settlement of waste and ultimate land use will not affect the structural integrity of the final cover.

- Erosion-resistant layer: 27 CCR § 21090(a)(3). This section requires that closed landfills be provided with an uppermost cover layer, which should directly overlay the low-hydraulic-conductivity layer, consisting of either a vegetative layer consisting of not less than 1 foot of soil capable of sustaining native or other suitable plant growth or a mechanically erosion-resistant layer.
- Emergency Response: 27 CCR § 21130. The substantive provisions of this section requires that (1) occurrences that may exceed the site design and endanger public health or the environment be identified; (2) specific procedures that minimize these hazards to protect public health and safety be established; and (3) hazard mitigation procedures also address vandalism, fires, explosions, earthquakes, floods, the collapse or failure of artificial or natural dikes, levees, or dams, surface drainage problems, and other waste releases.
- Site Security: 27 CCR §§ 21135(f) and (g). This section requires that all points of site access must be restricted, except at permitted entry points, and that all monitoring, control, and recovery systems be protected from unauthorized access. Once closure activities are complete, site access by the public may be allowed in accordance with the approved post-closure maintenance plan.
- Structure Removal: 27 CCR § 21137. This section requires that the operator dismantle and remove site structures at the time of closure to protect public health and safety in accordance with the implementation schedule of the approved final closure plan.
- Final Cover: 27 CCR §§ 21140(a) and (b). This section requires that the final cover function with minimum maintenance and that it provide waste containment to protect public health and safety by controlling at a minimum, vectors, fire, odor, litter, and landfill gas migration. The final cover must also be compatible with post-closure land use.
- Final Grading: 27 CCR § 21142(a). This section requires final grades to be designed and maintained to reduce impacts to health and safety, and to take into consideration any post-closure land use.
- Final Grading: 27 CCR § 21090(b)(1). This section specifies that the final cover be designed and maintained to prevent ponding with final slopes no less than 3 percent. The Navy has determined that the substantive provisions of 27 CCR § 21090(b)(1) are relevant and appropriate for containment actions in the Landfill Area; however, this section is not relevant and appropriate for containment actions in the Panhandle, East Adjacent, and Shoreline Areas. This determination is discussed in Section N4.3.1 of Appendix N.
- Slope Stability: 27 CCR § 21145(a)(5). This section requires the operator to ensure the integrity of final slopes under both static and dynamic conditions to protect public health and safety, and to prevent damage to post-closure land uses, roads, structures, utilities, gas monitoring and control systems, and leachate collection and control systems to prevent public contact with leachate and to prevent exposure of waste.

- Drainage and Erosion Control: 27 CCR § 21150(a). This section requires that the drainage and erosion control system be designed and maintained to ensure the integrity of post-closure land uses, roads, and structures; prevent public contact with waste and leachate; ensure integrity of gas monitoring and control systems; prevent safety hazards; and prevent exposure of waste.
- Post-closure Maintenance: 27 CCR § 21180(a). This section requires post-closure maintenance and monitoring of the landfill for no less than 30 years following closure.
- Post-closure Land Use: 27 CCR §§ 21190(a), (b), (d), (e), (f) and (g). These sections require that post-closure land uses be designed and maintained to protect health and safety; prevent contact with waste, landfill gas, and leachate; and prevent gas explosions. In particular, 27 CCR § 21190(g) specifies design and construction standards for "all on site construction within 1,000 feet of the boundary of any disposal area" to prevent landfill gas from migrating into buildings. The Navy has determined that the substantive provisions of 27 CCR § 21190(g) are relevant and appropriate for future construction within the Parcel E-2 boundary, including the portion of the Landfill Area that extends onto UCSF property, because Parcel E-2 may be affected by subsurface gas emanating from the Landfill Area. However, these provisions are not relevant and appropriate to future off site construction beyond the Parcel E-2 boundary because these areas are not affected by subsurface gas emanating from the Landfill Area. The interim gas control system and ongoing monitoring program are effectively controlling the migration of hazardous levels of landfill gas beyond the Parcel E-2 boundary. The permanent gas control system contemplated in this report (see Section 11.5.3) would continue to control the migration of hazardous levels of landfill gas beyond the Parcel E-2 boundary.

10.3.2. Action-Specific Applicable or Relevant and Appropriate Requirements for Construction and Grading

The regulations summarized below pertain to construction and grading operations. The substantive provisions of these requirements are identified in Sections N4.2.2 and N4.3.2 of Appendix N and are accepted as potential ARARs.

- Title 17 California Code of Regulations § 93105. This section sets forth requirements for road construction and maintenance and for construction and grading operations in soil containing naturally occurring asbestos, serpentine, or ultramafic rock.
- SWRCB Remediation Activities: 27 CCR § 20090(d). This section specifies that actions taken by or at the direction of public agencies to clean up or abate conditions of pollution or nuisance resulting from unintentional or unauthorized releases of waste or pollutants to the environment are exempt from the 27 CCR waste pile requirements provided that wastes or contaminated materials removed from the immediate place of release shall be discharged or contained in accordance with applicable SWRCB-promulgated provisions of this division to the extent feasible.

10.3.3. Action-Specific Applicable or Relevant and Appropriate Requirements for Shoreline Construction

The regulations summarized below pertain to construction within the shoreline area. Because shoreline construction may involve the discharge of fill material into waters of the United States, the substantive provisions of these requirements are identified in Section N4.2.3 of Appendix N and are accepted as potential ARARs.

- 22 CCR § 66264.553(b), (d), (e), and (f). These sections set forth alternative requirements that are protective of human health or the environment, and that may replace design, operating, or closure standards for temporary tanks and container storage areas. These sections may apply to the temporary storage of dredged sediment from excavation activities.
- 40 CFR § 264.554 (d)(1)(i) through (ii), (d)(2), (e), (f), (h), (i), (j), and (k). These temporary staging pile requirements are applicable to excavated sediment that meets the definition of RCRA hazardous waste and relevant and appropriate to excavated soil that does not meet the definition of RCRA hazardous waste.
- 33 CFR § 320.4. This section presents general policies for evaluating permit applications for proposed discharge of dredged or fill material into waters of the United States (Note: Only substantive provisions of this regulation are considered ARARs; CERCLA response actions are exempt from permit requirements pursuant to Section 121[e] of CERCLA).
- 33 CFR § 330.1(e)(3). This section identifies terms and conditions under the nationwide permit program for discharges into wetlands.
- 40 CFR § 230.10. This section describes specific restrictions on the discharge of dredged or fill material into waters of the United States.
- 40 CFR § 230.11. This section identifies the factual determinations necessary for making a finding of compliance with 40 CFR § 230.10.
- 40 CFR §§ 230.20–230.25, 230.31, 230.32, 230.41, 230.42, and 230.53. These sections identify relevant factors to consider when evaluating the potential impacts of a discharge of fill material.
- 40 CFR §§ 230.70–230.77. These sections identify potential actions to minimize adverse impacts of a discharge of fill material.
- 40 CFR § 230.93. This section identifies general requirements for compensatory mitigation to offset losses from unavoidable impacts to waters of the United States.
- 40 CFR §§ 230.94(c), 230.95, 230.96, and 230.97. These sections identify required content for mitigation plans, including ecological performance standards and monitoring/management requirements.
- San Francisco Bay Plan, Parts III and IV. The substantive provisions of the policies contained within Parts III and IV are potential ARARs. The subject sections pertain to protection of specific coastal resources (such as, tidal marshes and tidal flats) and identify specific conditions under which fill material may be placed in San Francisco Bay.

The Navy has evaluated the proposed remedial alternatives relative to the substantive provisions of the above requirements. This evaluation, presented in Appendix O, demonstrates that the proposed remedial alternatives can be designed in a manner to comply with the substantive provisions of the above requirements.

10.3.4. Action-Specific Applicable or Relevant and Appropriate Requirements for Landfill Gas Monitoring and Control

The regulations summarized below pertain to continued operation and maintenance of the existing gas control system at the Parcel E-2 Landfill. The substantive provisions of these requirements are identified in Section N4.3.3 of Appendix N and are accepted as potential ARARs.

- Gas Emission, BAAQMD Regulation 8, Rule 2. This rule requires that a person shall not discharge into the atmosphere from any miscellaneous operation an emission containing more than 6.8 kilograms (15 pounds) per day and containing a concentration of more than 300 ppm of total carbon on a dry basis.
- Landfill Gas Monitoring: 27 CCR § 20923. This section states that, to ensure that the conditions of § 20921 are met, general standards for a landfill gas monitoring network are required.
- Perimeter Monitoring: 27 CCR § 20925. This section requires that perimeter monitoring wells be installed around the waste and specifies the location, spacing, depth and construction requirements for the perimeter monitoring system.
- Structure Monitoring: 27 CCR § 20931. This section requires that the monitoring network design include provisions for monitoring on-site structures such as buildings, subsurface vaults, utilities, and any other areas where potential gas buildup would be of concern.
- Monitored Parameters: 27 CCR § 20932. This section requires that all monitoring probes and on-site structures be sampled for methane during the monitoring period.
- Monitoring Frequency: 27 CCR § 20933. This section requires quarterly monitoring at a minimum. More frequent monitoring may also be required at locations where monitoring results indicate that landfill gas migration is occurring or is accumulating in structures.
- Methane Control: 27 CCR § 20937. This section describes the actions required when results of gas monitoring indicate that concentrations of methane exceed levels set forth in 27 CCR § 20921(a).

10.3.5. Action-Specific Applicable or Relevant and Appropriate Requirements for Groundwater Monitoring

The regulations summarized below pertain to groundwater monitoring. The substantive provisions of these requirements are identified in Section N4.2.5 of Appendix N and are accepted as potential ARARs.

- 22 CCR § 66264.310(b)(3). This section requires that the groundwater system be maintained and monitored after closure of a waste management unit in accordance with the applicable requirements of Article 6, Chapter 14.
- 22 CCR § 66264.93. This section identifies the COC requirements.
- 22 CCR § 66264.95. This section identifies the point of compliance.
- 22 CCR § 66264.97(b)(1)(A), (b)(1)(D)(1) and (2). This section establishes a sufficient number of groundwater monitoring points.

- 22 CCR § 66264.97(b)(4), (5), (6), and (7). This section identifies monitoring well construction requirements and sampling intervals.
- 22 CCR § 66264.97(e)(6),(e)(12)(A), (e)(12)(B), (e)(13), and (e)(15). This section identifies sample collection requirements.
- 22 CCR § 66264.100(d). This section requires the implementation of a corrective action monitoring program.

The following potential ARARs pertain to disposal of any investigation derived waste (IDW) generated in the implementation of this alternative and the implementation of the excavation and off-site disposal alternative.

- 22 CCR §§ 66262.10(a) and 66262.11. These sections require the Navy to determine if any IDW is hazardous waste.
- 22 CCR § 66264.13(a) and (b). This section sets requirements for analyzing waste to determine if it is hazardous.
- 27 CCR § 20200(c). This section requires accurate characterization of waste.
- 27 CCR § 20210. This section requires that designated waste be discharged to Class I or Class II waste management units.
- 27 CCR § 20220(b), (c), and (d). This section requires that nonhazardous solid waste be discharged to a classified waste management unit.

10.3.6. Action-Specific Applicable or Relevant and Appropriate Requirements for Surface Water Monitoring and Management

The regulations summarized below pertain to surface water runoff monitoring and management. The substantive provisions of these requirements are identified in Section N4.2.4 of Appendix N and are accepted as potential ARARs.

- 40 CFR § 122.44(k)(2) and (4). This section, pursuant to which SWRCB Order 99-08 (SWRCB, 1999) was issued, specifies the use of BMPs to reduce pollutants during construction that disturbs at least 1 acre. These requirements are potentially applicable during closure activities.
- 22 CCR § 66264.97(c)(1) and (c)(2)(B). This section requires that a monitoring system be established to monitor each surface water body and to ensure the earliest possible detection of a release from a regulated unit. These requirements are potentially applicable during post-closure activities.

10.3.7. Action-Specific Applicable or Relevant and Appropriate Requirements for Institutional Controls

The following requirements pertain to implementation of institutional controls. The substantive provisions of these requirements are identified in Section N4.2.6 of Appendix N and are accepted as potential ARARs.

- California Civil Code § 1471. The substantive provisions of this section are potential ARARs. This section provides conditions under which land use restrictions will apply to successive owners of land.
- California Health and Safety Code § 25202.5. This section allows DTSC to enter into an agreement to restrict land uses.
- California Health and Safety Code § 25232(b)(1)(A)-(E). This section sets forth land use restrictions for hazardous waste property.
- California Health and Safety Code § 25233(c). The substantive provisions of this section for obtaining written variances from land use restrictions are identified in Section N4.2.6 of Appendix N and are accepted as ARARs. Procedural requirements do not qualify as ARARs.
- California Health and Safety Code § 25234. The substantive provisions of this section for removing land use restrictions are identified in Section N4.2.6 of Appendix N and are accepted as ARARs. Procedural requirements do not qualify as ARARs.
- California Health and Safety Code §§ 25222.1 and 25355.5(a)(1)(C). These sections provide DTSC the authority to enter into voluntary agreements with land owners to restrict use of property. The substantive provisions of this requirement are identified in Section N4.2.6 of Appendix N.
- 22 CCR § 67391.1. The Navy recognizes that the substantive provisions of 22 CCR § 67391.1 are state ARARs as stated in Section N4.2.6 of Appendix N.

10.3.8. Action-Specific Applicable or Relevant and Appropriate Requirements for Leachate Collection and Control

The regulations summarized below pertain to leachate collection and control. The substantive provisions of these requirements are identified in Section N4.3.5 of Appendix N and are accepted as potential ARARs (if required based on groundwater monitoring results).

- 22 CCR § 66264.310(b)(2). This section requires that, based on groundwater monitoring results, leachate collection and removal will be performed until no longer detected.
- 27 CCR § 21160(a) and (c). This section requires that leachate control be implemented and maintained in a manner that prevents public contact and controls vectors, nuisance, and odor.

10.3.9. Action-Specific Applicable or Relevant and Appropriate Requirements for Excavation and Off-Site Disposal

The following regulations pertain to excavation and off-site disposal activities. The substantive provisions of these requirements are identified in Section N4.2.1 of Appendix N and are accepted as potential ARARs.

- 40 CFR §§ 264.554(a), (d), (g), (h), (i), (j), and (k). This section is a RCRA requirement that allows the accumulation of waste and temporary storage on the contiguous property for up to 2 years during remedial operations.
- 22 CCR §§ 66264.553(b), (d), (e), and (f). This section sets forth alternative requirements that are protective of human health or the environment and that may replace design, operating, or closure standards for temporary tanks and container storage areas. These sections may apply to the temporary storage of extracted groundwater associated with excavation prior to treatment and discharge.
- 40 CFR § 403. The substantive provisions of this section, which specify pre-treatment standards, are potentially applicable if groundwater is treated on-site and discharged to a publicly owned sanitary sewer system.
- BAAQMD Regulation 6, Rule 302. This regulation prohibits airborne emissions as dark as or darker than No. 1 on the Ringelmann Chart and sets forth opacity requirements.
- 40 CFR § 761.61(c). This section provides a risk-based option for the disposal of PCB remediation waste.