ATTACHMENT A

REFERENCES

(Reference documents provided on CD only)

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
1	**Parcel D-2**	Section 2.1	Final Status Survey Results, Building 813, Hunters Point Shipyard, San Francisco, California. Sections 1.1 and 1.2. Tetra Tech EC, Inc. September 12, 2007. Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.1. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
2	**Hydrogeologic setting**	Section 2.2	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Sections 2.2.2 through 2.2.4. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
3	**Hydrostratigraphic units**	Section 2.2	Final Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Sections 2.2.7 and 2.2.8. SulTech. November 30, 2007.
4	**Inventory**	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 2.1.1, page 8, and Table I-1, page 2. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
5	**Removed**	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.2, pages 57 and 58. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
6	**Backfilled and paved**	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.2, pages 59 and 60. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
7	**Results**	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.3, pages 60 to 61. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
8	**Regulatory agency concerns**	Section 2.3	Draft Report of Results for Work Plan Addendum No. 4, Parcel A Site Inspection Report, Hunters Point Annex, San Francisco, California. Section 1.0, page 1. Harding Lawson Associates. October 29, 1993.
9	**Basewide HRA**	Section 2.3	Final Historical Radiological Assessment, History of the Use of General Radioactive Materials, 1939 – 2003. Section 8.3.4.18 and Figure 8.3.4.18, pages 8-129 to 8-131. Naval Sea Systems Command. October 2004.
10	**Potential radiological contamination**	Section 2.3	Final Historical Radiological Assessment, History of the Use of General Radioactive Materials, 1939 – 2003. Table 8-2, page 5 of 11. Naval Sea Systems Command. October 2004.
11	**Boundary**	Section 2.3	Final Finding of Suitability to Transfer for Parcel A (Revision 3), Hunters Point Shipyard, San Francisco, California. Section 2.0, pages 5 and 6. Tetra Tech EM Inc. October 14, 2004.
12	**Released**	Section 2.3	Final Status Survey Results, Building 813, Hunters Point Shipyard, San Francisco, California. Section 11.0. Tetra Tech EC, Inc. September 12, 2007.
13	**Unrestricted use**	Section 2.3	Recommendation for Unrestricted Release for Building 813 and Building 819, Hunters Point Shipyard, San Francisco, California. Letter from Thomas P. Lanphar, DTSC. To Keith Forman, Department of the Navy. April 14, 2008.
14	**Groundwater**	Section 2.4	Record of Decision for Parcel A, Hunters Point Annex, San Francisco, California. Section 2.6.1, Page 17. Department of the Navy, EFA WEST, San Bruno, California. November 16, 1995.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
15	**Risk**	Section 2.5	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 6.0, page 64. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.
16	**Conceptual site model**	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Figure A.3-1. Tetra Tech EC, Inc. April 11, 2008.
17	**Radiological risk**	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Section 2.0, pages A.2-1 through A.2-5. Tetra Tech EC, Inc. April 11, 2008.
18	**RESRAD-BUILD**	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Section 5.0, pages A.5-1 and A.5-2. Tetra Tech EC, Inc. April 11, 2008.
19	**Total radiological risks**	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Table 3-3. Tetra Tech EC, Inc. April 11, 2008.
20	**Assumptions and uncertainties**	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Section 6.0, pages A.6-1 through A.6-3. Tetra Tech EC, Inc. April 11, 2008.
21	**Ecological risk assessment**	Section 2.5.2	Draft Final Parcel A Remedial Investigation Report, Hunters Point Shipyard, San Francisco, California. Section 6.2, Pages 6-13 through 6-17. PRC Environmental Management, Inc. and Harding Lawson Associates. September 22, 1995.
22	**IR Program website**	Section 2.6	http://www.bracpmo.navy.mil/

[1]Bold blue text indicates hyperlinks available on reference CD to detailed site information contained in the publicly available Administrative Record.

For access to information contained in the Administrative Record for Hunters Point Shipyard, please contact:

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Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
1	**Parcel D-2**	Section 2.1	Final Status Survey Results, Building 813, Hunters Point Shipyard, San Francisco, California. Sections 1.1 and 1.2. Tetra Tech EC, Inc. September 12, 2007. Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.1. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.

1.0 SITE DESCRIPTION

1.1 SITE LOCATION AND DESCRIPTION

Building 813 is a 262-by-262-foot, four-story reinforced concrete, flat-roofed warehouse that includes banks of industrial steel sash in horizontal bands across all four stories, except at the front of the first floor on the south end of the building. The front has a bank of steel roll-up industrial doors extending the length of the concrete loading dock area sheltered by a concrete canopy.

Figure 1-1 provides a map of the site location.

1.2 PRIOR HISTORICAL USE

The Historical Radiological Assessment (HRA), Volume II (Naval Sea Systems Command [NAVSEA], 2004), states that Building 813 was previously used for the following purposes:

- General warehouse and offices
- Supply storehouse
- Disaster Control Center (DCC)

Historically, a leaking 300 microcurie (µCi) strontium-90 (^{90}Sr) check source was found in the disaster control inventory, and the DCC was located inside of Building 813. While conducting a walkthrough of the building, a cabinet was identified bearing a radioactive materials placard. Since the origin of the cabinet is unknown, additional radioisotopes may be present in the building. The most prevalent isotopes that have been encountered at HPS have been cesium-137 (^{137}Cs) and radium-226 (^{226}Ra).

1.3 CURRENT AND FUTURE BUILDING OR LAND USE

Building 813 is currently vacant and unoccupied. The planned future use identified in the San Francisco Redevelopment Agency (SFRA) Reuse Plan (SFRA, 1997) is as a "mixed use" area, which may include residential areas.

Analytical results indicate minimal impact by organic chemicals, as low levels of carcinogenic and noncarcinogenic PAHs were detected. Carcinogenic PAHs were not detected in samples collected deeper than 18 inches below the original grade, except for Samples 14243021 and 14243037, which contained low levels of benzo(a)anthracene and chrysene. Motor oil was detected at a maximum concentration of 200 mg/kg and TOG was detected at a maximum concentration of 1,100 mg/kg. Aluminum, arsenic, lead, and zinc were detected in some samples at concentrations exceeding IALs.

Contaminated soil at PA-43 was removed and disposed of offsite during the SI. As discussed in Section 6.0 and Appendix F, after the contaminated soil was removed, the risk levels of the confirmatory soil samples approach that of background and are considered de minimis at this site. Therefore, no further investigation of PA-43 is recommended.

4.6 UST S-812 INVESTIGATION

The former UST S-812 was located near Building 813 (Plate 2). The history and description of UST S-812 are presented in the following subsection, followed by a description of the field investigation and observations, a summary of the results, and an evaluation of the available data. Currently, work is being conducted following work Plan Addendum No. 4 (PRC, 1993d) looking at confirming previously identified VOC constituents in the groundwater at this site. The results will be presented as an addendum to this draft final report.

4.6.1 Site History and Description

The former UST S-812 was located underneath an asphalt parking lot approximately 20 feet east of Building 813. The steel UST was installed in 1976 and used to store fuel oil for a boiler in Building 813. Sometime after the UST installation, the boiler was converted to natural gas and the tank was no longer needed. It is unknown when the UST was removed from service. The capacity of UST S-812 was previously reported as 10,000 gallons. However, based on visual inspection after removal, the capacity of the UST was estimated to be between 18,000 and 20,000 gallons.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
2	Hydrogeologic setting	Section 2.2	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Sections 2.2.2 through 2.2.4. PRC Environmental Management, Inc. and Harding Lawson Associates. October 15, 1993.

2.2 PHYSICAL CHARACTERISTICS OF HPA

This section summarizes current knowledge of HPA's physical characteristics with a focus on Parcel A. Specifically, the following subsections summarize the surface features and topography, geology, hydrogeology, surface water drainage, ecology, and meteorology of HPA.

2.2.1 Surface Features and Topography

Between 70 and 80 percent of the land area of HPA is relatively level lowlands constructed by excavating portions of the hillside and placing fill materials along the Bay margin. The remaining land, composing much of Parcel A, is a moderately to steeply sloping ridge in the northwest portion of the facility. Elevations range from 0 to 18 feet above mean sea level (MSL) in the lowlands to 180 feet MSL at the ridge crest in Parcel A. Material from the ridge was used for filling the lowlands and constructing building pads, except in the area of Site IR-1, located at the southwestern boundary of HPA outside of Parcel A, which was created by landfilling with similar native materials mixed with industrial debris and refuse. Much of Parcel A consists of dilapidated, unoccupied single-family houses, occupied mixed-use commercial buildings, and concrete foundations. Most of the lowlands are covered by asphalt, buildings, or other structures. Parcel A's open areas are sparsely to fully vegetated, or bare soil.

2.2.2 Geology

Six geologic units underlie HPA, the youngest of Quaternary age and the oldest being Franciscan Bedrock of Jurassic-Cretaceous age. In general, the stratigraphic sequence of these units, from top to bottom, is as follows: Artificial Fill (Qaf); Slope Debris and Ravine Fill (Qsr); Undifferentiated Upper Sand Deposits (Quus); Bay Mud Deposits (Qbm); Undifferentiated Sedimentary Deposits (Qu); and Franciscan Bedrock. The peninsula forming HPA is within a northwest trending belt of Franciscan Bedrock known as the Hunters Point Shear Zone (Bonilla 1971). This belt extends diagonally through the City of San Francisco from Hunters Point to the south abutment of the Golden

Gate Bridge. The rocks within this belt are intensely deformed and sheared. Serpentinite is the predominant rock type, but other rock types characteristic of the Franciscan Bedrock are also present. The contacts between different rock types are typically sheared.

Bedrock occurs near the ground surface throughout much of Parcel A. A previous study Bonilla (1971) mapped bedrock in Parcel A as predominantly serpentinite, and sandstone and shale. Lesser amounts of chert and greenstone are also present. Plate 3 (Appendix J) provides an update of the Bonilla, 1971 geologic map.

Bedrock in the elevated portions of Parcel A is locally overlain by poorly consolidated Slope Debris and Ravine Fill (Qsr). Landslide deposits have been identified in the cut slope southwest of Coleman Street.

In some low-lying areas, bedrock is overlain by Undifferentiated Sedimentary Deposits consisting of consolidated sands and clays. These are overlain by relatively extensive Bay Mud Deposits (Bay mud) consisting of soft, highly organic, plastic clay and silt with interbedded lenses of sand and peat. In some areas of HPA, the Bay mud is overlain by poorly graded sands and silty sands designated as the Undifferentiated Upper Sand Deposits, which may be native or hydraulically deposited from dredging operations. Artificial Fill covers the bedrock, Bay mud, or Undifferentiated Upper Sand Deposits over most of the low-lying areas at HPA. This fill is of two types: bedrock-derived fill from upland areas of Parcel A and industrial fill consisting of domestic and industrial wastes including sandblast materials and construction debris. Colluvial deposits, referred to as Slope Debris and Ravine Fill by Bonilla (1971), may also be present locally above the Franciscan Bedrock, the Bay mud, or the Undifferentiated Upper Sand Deposits. Slope Debris and Ravine Fill are difficult to differentiate from bedrock-derived Artificial Fill. The higher elevations of Parcel A consist of the bedrock covered by sandy, silty, clayey, and surficial soils. Detailed descriptions of the geologic units at HPA are presented in Appendix A.

2.2.3 Hydrogeology

For the purposes of this report, an aquifer is defined as saturated, relatively permeable, native geologic, or manmade material that occurs at similar stratigraphic elevations, is relatively continuous in lateral extent, is of similar depositional origin, and appears to be in hydraulic continuity based on water-level data. Three aquifers have been identified at HPA and are designated the A-aquifer, the undifferentiated sedimentary or B-aquifer, and the Bedrock aquifer. The A- and B-aquifers are separated by Bay mud 5 to 60 feet thick under most of the low-lying areas at the facility. The fine-grained portions (clay and silt) of the Bay mud generally act as an aquitard between the two aquifers.

The A-aquifer consists of saturated fill materials and Undifferentiated Upper Sand Deposits overlying Bay mud. The A-aquifer may overly bedrock in excavated areas adjacent to the former shoreline. In the lowland areas of HPA, it is generally unconfined to semiconfined, with depths to groundwater ranging from 2 to 15 feet below ground surface (bgs). Plate I-1 in Appendix I presents the results of water level measurements collected facility wide on August 16, 1993. The B-aquifer consists of Undifferentiated Sedimentary Deposits underlying Bay mud and overlying Franciscan Bedrock. The Bedrock aquifer is the upper weathered and deeper fractured portions of the Franciscan Bedrock (considered an aquifer in certain areas of the facility); it appears to be in direct hydraulic communication with the A-aquifer where the A-aquifer directly overlies it. Deeper fractured portions of the bedrock may also act as aquifer materials. Only limited data are currently available for the B- and Bedrock aquifers.

As seen on Plate I-1, groundwater flow at HPA is complex due to the heterogeneity in the hydraulic properties of the subsurface fill materials, tidal influences, effects of storm drain and sanitary sewer systems, and variations in topography. In some areas, the groundwater flow direction has been observed to vary with tidal fluctuations, indicating groundwater exchange with San Francisco Bay. Rainfall is likely to result in localized groundwater recharge in unpaved areas where infiltration can occur. Groundwater flow in southern parts of the facility (that is, IR-2 and IR-3) is generally inland and appears to be strongly influenced by HPA's sanitary sewer system. Consequently, water from the bay appears to recharge the A-aquifer fill materials along the south shore. Groundwater flow north of the bedrock ridge in the center of HPA (that is, Sites IR-6, IR-7, IR-10, and IR-18) is toward the bay.

Conditions at Parcel A

Groundwater recharge into the bedrock portions of Parcel A would result from infiltration of precipitation, surface runoff, or other sources of surface flow where these flows encounter soil or rock of suitable permeability. The sloping nature of Parcel A and the presence of paved areas and surface drainage features suggest that much of the Parcel A surface flow drains to the lowland areas below the ridge or is diverted directly into San Francisco Bay.

In general, the occurrence of groundwater in the Franciscan Bedrock is limited. Where groundwater is present in these rocks, it is commonly associated with small, open fractures, or other zones of secondary permeability. Where open fractures are abundant and interconnected, drinking water aquifers can occur. In the Franciscan Bedrock, these aquifers are typically of limited extent and associated with discrete zones of fracturing. Identification and detailed characterization of aquifers can be extremely difficult due to the highly deformed and complex nature of the Franciscan Bedrock.

Groundwater occurs in fill materials in Parcel A and may also occur in bedrock. Bedrock is at or near the ground surface throughout most of Parcel A. Specific characterization of groundwater conditions in the former residential area near PA-43 was performed as part of Addendum No. 3 to the Work Plan (Appendix J). A general assessment of conditions expected in the various geologic and topographic settings in Parcel A is presented in the following paragraphs.

Available data on the occurrence of groundwater in bedrock in Parcel A were gathered from the borings installed as part of the SI activities for the PA-50 storm drains in the area near PA-43 (Building 906). During the SI, shallow borings (up to 22 feet) were drilled adjacent to PA-43. These borings indicated dry rock with moisture contents ranging from 3 to 25 percent, and did not encounter groundwater. Results from the additional borings near PA-43 indicated groundwater was not found to a total depth of 80 feet (Appendix J).

Two borings were drilled north and northwest of PA-43 to depths of 200 feet. The boring drilled north of PA-43 encountered very minor quantities of groundwater in a limited number of moist or wet zones of bedrock. Northeast of PA-43 groundwater was encountered at a depth of 72 feet bgs; water levels in the boring stabilized at 37 feet bgs with an estimated inflow rate ranging from 0.19 to 0.27 gallons per minute (gpm) (Appendix J).

Springs and seeps are found in two general areas of Parcel A. On the southeast-facing cut slope behind Building 808, seepage occurs at elevations ranging from 20 to 70 feet MSL at an estimated flow rate of up to 1 or 2 gpm. Seepage is conspicuously absent on the southwest-facing slope of this area. Southwest of Building 101 seasonal seepage appears to be associated with a serpentinite/graywacke-shale contact at an elevation of 30 to 60 feet MSL (Plate 3, Appendix J).

Groundwater in the lower portions of Parcel A occurs either in bedrock or in surficial fill deposits overlying bedrock. At this lower elevation, Parcel A slopes gently in the direction of San Francisco Bay. These lowland areas are largely the result of hillside excavation as part of the HPA base development. As a consequence, the excavated areas are underlain by localized accumulations of fill, native surficial soils, and bedrock. Prior to the development of Navy facilities at Hunters Point, the Bay shoreline extended into what is now the southern boundary of Parcel A along Crisp Avenue. The former shoreline extended into Parcel A for a maximum distance of approximately 150 feet in the vicinity of PA-41 and Buildings 808 and 815, an area now regraded to an elevation of approximately 15 to 30 feet MSL (Plate I-1; Appendix I).

The former shoreline approximately represents the upgradient limit of the A-aquifer. Groundwater flow in the soil deposits of the Parcel A lowland areas, is generally away from Parcel A toward San Francisco Bay as shown on Plate I-1. Existing site topography and the former topography (now largely obscured by fill) generally slopes away from Parcel A and is believed to influence the groundwater flow directions. At IR-6, IR-7, and IR-10, located near Parcel A on the flank of the bedrock high, groundwater gradients measured in September 1991 and February 1992 are consistent with the water levels measured in August 1993, and also indicate groundwater flow is away from Parcel A along its north and east boundary (HLA 1992d, 1993b, 1993d; Plate I-1). South of Crisp Avenue, near the Parcel A south boundary (at IR-1 and IR-4), groundwater flow is southeasterly with groundwater elevations ranging from approximately 4.5 to -0.5 feet MSL. Near this location, the former shoreline extended into Parcel A with the former ground surface rising abruptly from the bay, forming a south-facing hill slope. It is likely that groundwater within the thin fill, now present at PA-41, is influenced by this buried topography and results in southward groundwater flow from Parcel A toward Crisp Avenue. Findings from the HPA tidal influence monitoring studies (HLA 1992g) do not indicate direct tidal influence on groundwater within Parcel A.

A study further characterizing groundwater in the bedrock of Parcel A has been performed as part of the SI; the results are presented as Appendix J to this report (HLA 1993d).

2.2.4 Surface Water Drainage

Surface water drainage at Parcel A appears to be primarily sheet-flow runoff collected by an onsite storm drain system and discharged via the storm drain system in adjacent parcels into San Francisco Bay through several outfalls. Locally, some surface runoff may enter catch basins connected to the sanitary sewer system. Some of these basins, remnants of the formerly combined storm drain and sanitary sewer system, are present along Coleman Street, adjacent to PA-43. Ultimately such flows are discharged to the San Francisco sanitary sewer system. No naturally occurring channelized drainage exists; any preexisting drainage channels have been filled or modified by construction over the years. Drainage channels have not developed from the springs and seeps noted on the south-facing cut-face slopes. Runoff from these areas, if present, is captured by the storm drain system or ponds in low-lying areas.

2.2.5 Ecology

As previously stated, most of HPA is currently covered by asphalt, buildings, or other structures. The vegetated areas of the facility comprise four distinct terrestrial habitats. In order of decreasing area, these areas are ruderal (disturbed), landscape, nonnative grassland, and salt marsh. All four habitats are somewhat disturbed as a result of past and current activities, with ruderal habitats the most highly disturbed.

San Francisco Bay at HPA is characterized by strong tidal currents. Physical structures such as riprap and docks serve as artificial habitats for estuarine life. The marine environment is disturbed as a result of activities in the Bay. Several hundred species of plants and animals, including the following, are believed to occur at or near HPA: terrestrial and marine plants and algae; benthic and water column-dwelling marine animals such as clams, mussels, amphipods, and fish; insects; amphibians; reptiles; birds; and mammals (ESA, 1987). No special status species (i.e., threatened or endangered species) inhabit or use the Hunters Point vicinity (ESA, 1987).

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
3	Hydrostratigraphic units	Section 2.2	Final Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Sections 2.2.7 and 2.2.8. SulTech. November 30, 2007.

No other potential terrestrial receptors or habitat have been identified at Parcel D. It is unlikely that Parcel D will contain terrestrial habitat in the future because its proposed reuse is primarily industrial.

2.2.6 Parcel D Soils

Soils at HPS are either the result of (1) weathered material from nearby rock formations and sediments from the Bay or (2) imported fill material placed at HPS during its development. The area northwest of Parcel D is primarily covered by upland soils, which are moderate to steeply sloped terrains. Parcel D is primarily lowland soils, which are flat to gently sloped urban developed lands. These lowland soils are susceptible to subsidence by natural compaction or during moderate to strong earthquakes. Soils at HPS are described in detail in Appendix H of the draft final Parcel D RI report (PRC, LFR, and U&A 1996). Figure 2-4 shows the distribution of soils at HPS.

2.2.7 Parcel D Geology

The peninsula forming HPS is within a northwest-trending belt of Franciscan Complex bedrock known as the Hunters Point Shear Zone. In some locations, the Marin Headlands Terrane underlies this shear zone. HPS is underlain by five geologic units, the youngest of Quaternary age, and the oldest, the Franciscan Complex bedrock, of Jurassic-Cretaceous age. In general, the stratigraphic sequence of these geologic units, from youngest (shallowest) to oldest (deepest), is as follows: Artificial Fill; Undifferentiated Upper Sand Deposits; Bay Mud Deposits; Undifferentiated Sedimentary Deposits; and Franciscan Complex Bedrock. The locations of the fill material, the colluvium, alluvium and landslide debris, and the chert, shale, sandstone, volcanic, and serpentine bedrock units at HPS are shown on Figure 2-5.

The Navy believes that the practice of using quarried local rock for fill at HPS is similar to construction practices in the same bedrock formations used elsewhere in San Francisco. The Navy observed that a wide range of concentrations of metals are found in similar chert, basalt, and serpentinite bedrock formations in other areas of San Francisco based on sampling that the Navy conducted in 2003 at areas outside of HPS. This information is summarized in a report titled "Draft Metals Concentrations in Franciscan Bedrock Outcrops" (Tetra Tech and Innovative Technical Solutions, Inc. [ITSI] 2004).

In the Tetra Tech and ITSI 2004 report, the Navy studied the ambient concentrations of metals in bedrock and bedrock-derived soil from three nonindustrial sites in San Francisco. These three sites have a similar geologic setting to HPS and contain serpentinite or chert and basalt bedrock typical of the Franciscan Complex. The sites included the two Franciscan Complex subunits that form the HPS peninsula: the Hunters Point Shear Zone and the Marin Headlands Terrane. The investigation included about 30 rock and soil samples from each of the three sites (91 samples total) that were analyzed for metals using a standard analytical suite of EPA methods. The study found elevated concentrations of arsenic, iron, and manganese associated with chert bedrock and elevated nickel concentrations associated with serpentinite. The chemical composition of soil at the three sites was found to be similar to the chemical composition of rock. Of the 91 samples collected, none met the cleanup standards for unrestricted residential reuse at HPS because of the elevated ambient concentrations of these metals in the serpentinite bedrock and its derived soils. Based on this study, the Navy believes that the elevated concentrations of metals in the soils at HPS as represented by the HPALs, is also a result of the ambient metals concentrations in a serpentinite sourced fill material.

The draft final Parcel D RI report presented cross sections (see Figures 3.7-10 through 3.7-15 of that report) that depict the relationship of the various geologic units at the site (PRC, LFR, and U&A 1996). The geologic interpretations presented in the cross sections were updated in the 2002 draft Parcel D revised D FS based on data collected during the Phases I and II GDGI (Tetra Tech 2001a, 2001b). The cross section location map and the updated cross sections are presented on Figures 2-6 and 2-7.

The following description of the geologic setting at Parcel D summarizes the information presented on the updated cross sections. The bedrock at Parcel D is mainly composed of serpentinite belonging to the Hunters Point Shear Zone of the Franciscan Complex (Tetra Tech 2001b). The depth to Franciscan Complex Bedrock from the ground surface in Parcel D varies from less than 1 foot in the northern area to more than 120 feet in the southeastern area. Undifferentiated Sedimentary Deposits overlie bedrock over much of Parcel D, occurring beneath Bay Mud Deposits or, rarely, directly beneath Artificial Fill; these deposits range up to 80 feet thick. Bay Mud Deposits underlie most (about 80 percent) of Parcel D, except for a strip along the northern margin of the site. Where present, Bay Mud Deposits are typically 20 to 30 feet thick and are thickest (up to 40 feet) beneath the southeastern part of the parcel. Undifferentiated Upper Sand Deposits are discontinuous beneath Parcel D. These deposits generally overlie Bay Mud, but may interfinger with Bay Mud Deposits and, in a few localities, directly overlie Undifferentiated Sedimentary Deposits. The Undifferentiated Upper Sand Deposits generally range from a few feet to up to 40 feet thick. Artificial Fill overlies all of the naturally occurring units and ranges from approximately 2 feet thick in the north to 40 feet thick in the middle of Parcel D. In most of Parcel D, the artificial fill ranges from 20 to 30 feet thick. The thickness of the Artificial Fill and all sedimentary deposits generally increases toward the Bay. Table 2-2 summarizes the geology at each IR site located within Parcel D.

2.2.8 Parcel D Hydrogeology

This section summarizes the hydrostratigraphic units, groundwater flow patterns, and hydraulic characteristics of the main hydrogeologic units. Detailed descriptions of the hydrogeology at Parcel D are presented in the RI (PRC, LFR, and U&A 1996; PRC and LFR 1997) and Phase II and III GDGI reports (Tetra Tech 2001b, 2003a).

2.2.8.1 Hydrostratigraphic Units

The hydrostratigraphic units at HPS are (1) the A-aquifer, (2) the aquitard, (3) the B-aquifer, and (4) the deep bedrock water-bearing zone. Cross sections presented on Figure 2-7 show the hydrostratigraphic units in different colors, except for the deep (fractured) bedrock water-bearing zone, which is shown in white. The shallow (weathered) bedrock water-bearing zone near the boundary between the non-Navy property to the north and Parcel D (shown on the left side of cross section A-A’ on Figure 2-7) and at other locations is hydraulically connected with the A-aquifer and therefore is considered part of the A-aquifer in this location.

Shallow, unconfined groundwater occurs continuously across all of Parcel D in the A-aquifer. The A-aquifer at Parcel D consists mainly of unconsolidated artificial fill material that overlies the aquitard and bedrock. Undifferentiated Upper Sand is also part of the A-aquifer at some locations. Based on the cross sections shown on Figure 2-7, the A-aquifer consists mostly of sandy gravel and gravelly sand with limited zones of low-permeability sandy clay. Significant portions of the A-aquifer are also made up of less permeable fill. The A-aquifer typically ranges from 10 to 40 feet thick, but averages approximately 25 feet thick.

The aquitard is generally made up of silts and clays of the Bay Mud and Undifferentiated Sedimentary deposits. The aquitard ranges from 0 to 100 feet thick, but is most commonly 40 to 80 feet thick (see Figure 2-7). The aquitard is absent in the northern part of Parcel D where the A-aquifer is in direct contact with the bedrock and is thickest in the southeastern part of the parcel. The aquitard inhibits groundwater communication between the A-aquifer and the B-aquifer.

The B-aquifer is associated with the Undifferentiated Sedimentary deposits and consists of small, laterally discontinuous permeable sediment lenses of gravel, sand, silty sand, or clayey sand intermingled with the aquitard. The largest B-aquifer area is present near the center of Parcel D. The B-aquifer area at this location is estimated to be approximately 1,500 feet wide by 1,000 feet long, and is shown at its appropriate depth in cross sections A-A’ and C-C’ (see Figure 2-7). The B-aquifer varies from 20 to 30 feet thick. Groundwater in the discontinuous B-aquifer areas is under confined conditions. Table 2-2 summarizes the hydrogeologic units underlying each IR site.

2.2.8.2 Groundwater Flow Patterns and Tidal Effects

More than 85 percent of the ground surface at Parcel D is covered by pavement and buildings; as a result, most precipitation is channeled into the storm drain system. Unpaved areas may serve as localized vertical recharge areas. Leaking water lines also serve as limited sources of localized recharge. Base flow from the uplands north of Parcel D provides lateral groundwater recharge across the northern boundary of the parcel. Groundwater discharges directly to the Bay (1) along the shoreline, which is significantly modified by the presence of impermeable dry docks and sea walls in some areas, and (2) through permeable or semipermeable utility line corridors. In the past, groundwater that entered the sanitary sewer was discharged to the local publicly owned treatment works. Currently, the sanitary sewer system has been disconnected, and the sanitary sewers are being removed as part of a radiological removal action.

Groundwater flow patterns at Parcel D are complex because they are affected by (1) a groundwater sink located near the former western boundary of Parcel D (this area is now in Parcel E); (2) a groundwater mound located near the current western boundary of Parcel D (beneath IR-33, IR-44, IR-66, and IR-67); (3) leaks of groundwater into former sanitary sewers or storm drains; (4) recharge from water supply lines; and (5) tides in the Bay. Most groundwater at Parcel D flows toward the Bay, except in the western portion of Parcel D, which historically has flowed away from the mound and toward the groundwater sink in Parcel E (see Figure 2-8), where groundwater elevations are below mean sea level. The sink is believed to be caused by leaks of groundwater into sanitary sewer lines, which was then pumped off site to the local publicly owned treatment works, thereby lowering groundwater levels in the area. Flow patterns are anticipated to change as the sewer and storm drain lines are removed. Figure 2-9 shows the groundwater elevation contours from groundwater monitoring in March 2007.

The investigation of the bedrock underlying Parcel D has been limited and included areas where shallow bedrock and colluvium are hydraulically connected to the A-aquifer. In addition, the deep borings at Parcel D indicate the deeper bedrock underlying the Undifferentiated Sedimentary deposits consists mostly of fractured and moderately to strongly weathered serpentinite. Direct vertical hydraulic communication between the A-aquifer and the B-aquifer is inhibited because of the thick aquitard that separates them (see Figure 2-7). In addition, an upward vertical hydraulic gradient was observed at most well pairs installed at Parcel D (Tetra Tech 2004). Therefore, at Parcel D, migration of groundwater from the A-aquifer to the B-aquifer is considered minimal.

Tidal influence is the periodic fluctuation in the elevation of the groundwater table with time, caused by tide fluctuations in the Bay. Tidal influence may also include mixing or diluting groundwater with bay water, but the mixing usually does not occur as far inland as the fluctuations in groundwater elevation. The tidal influence zone is defined as the area where the maximum tidal fluctuation (difference in groundwater elevation between consecutive high and low tides) exceeds 0.10 foot. Based on tidal influence studies conducted during the RI (PRC, LFR, and U&A 1996) and the phase III GDGI (Tetra Tech 2003a), the tidal influence zone extends inland up to about 500 feet. Storm drains and utility corridors that are submerged below the water table could locally increase the magnitude of the tidal influence and the distance inland that is affected. Figure 2-3 shows the storm and sanitary sewer utility lines that are below the water table. The storm and sanitary sewer utility lines at Parcel D are scheduled for removal during 2007 and 2008.

2.2.8.3 Hydraulic Characteristics

The hydraulic conductivity of the A-aquifer at Parcel D typically ranges from 1 to 21 feet per day. The hydraulic conductivity was estimated based on data from slug and pumping tests performed during the RI (PRC, LFR, and U&A 1996). The minimum and maximum reported hydraulic conductivity values for IR sites located within Parcel D are 0.025 and 580 feet per day. The wide range of reported hydraulic conductivities indicates that the aquifer matrix is very heterogeneous. The A-aquifer consists primarily of heterogeneous artificial fill materials that vary from clay to silt to sand to gravel.

The estimated groundwater velocities at Parcel D range from 1.5 to 31 feet per year. These velocities were calculated using the typical intermediate value of hydraulic gradient for the A-aquifer throughout Parcel D of 0.001 (PRC, LFR, and U&A 1996) and an assumed effective porosity for the A-aquifer of 0.25. No slug test or pumping test evaluations were performed for the B-aquifer within Parcel D. However, slug tests were performed in two monitoring wells in the underlying fractured bedrock water-bearing zone at IR-09 in the north-central area of Parcel D (PRC, LFR, and U&A 1996), with estimated hydraulic conductivities ranging from 0.025 to 3.7 feet per day. In general, groundwater velocities in the fractured bedrock water-bearing zone is expected to be low because the flow occurs mostly through fractures that are likely filled with residual clays and silts (PRC, LFR, and U&A 1996).

2.2.9 Groundwater Beneficial Use Evaluation

This section summarizes the beneficial use evaluation conducted for groundwater underlying Parcel D. The complete beneficial use evaluation is presented in Appendix D. The potential beneficial uses of Parcel D groundwater have been evaluated several times in the past (see Appendix D; Tetra Tech 2001c). In 2003, the Navy concluded that A-aquifer groundwater at Parcel D is unsuitable for use as a potential source of drinking water based on an evaluation of site-specific factors (Navy 2003). In 2003, the Water Board concurred with the Navy’s determination that the A-aquifer at HPS is not a potential drinking water source (Water Board 2003). EPA, however, did not concur and required that federal criteria also be used to assess if Parcel D groundwater could be considered a potential drinking water source.

EPA considers groundwater to be a potential source of drinking water if the following criteria are met:

- The total dissolved solids (TDS) concentration is less than 10,000 milligrams per liter (mg/L)

- A minimum well yield of 150 gallons per day or 0.104 gallon per minute can be achieved

Figure 2-10 presents the maximum TDS concentrations detected in A-aquifer groundwater monitoring wells at Parcel D. As shown on Figure 2-10, TDS concentrations exceed 10,000 mg/L along the Parcel D shoreline and are less than 10,000 mg/L in the central and northwestern part of the parcel. The federal TDS criterion was applied separately to each IR site at Parcel D in this FS report. Based on this criterion, groundwater underlying all or part of the following 17 IR sites could be considered potential sources of drinking water: IR-09, IR-16, IR-17, IR-32, IR-33 North and South, IR-34, IR-37, IR-44, IR-48, IR-53, IR-55, IR-65, IR-66, IR-67, IR-68, IR-69, and IR-70. Based on known hydrogeologic conditions at Parcel D, it is assumed that a minimum well yield of 150 gallons per day could also be achieved from

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
4	Inventory	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 2.1.1, page 8, and Table I-1, page 2. PRC Environmental Management, Inc. and Harding Lawson Associates October 15, 1993.

In 1988, ERM-West conducted a fence-to-fence survey and inventory of suspected and known hazardous materials at the HPA facility (ERM-West 1988). All Navy and tenant facilities, including buildings, drydocks, piers, electrical substations, and open fields and lots were inspected. The investigation included Buildings 808, 813, 816, 818, 819/823, 901, 906, and 921 within Parcel A. The work did not include sampling or field testing of inventoried materials. The results of the investigation indicated problems with inadequate containment and labelling of chemicals being stored in Building 808 and staining on the floor of Building 906 (PA-43) where pesticides were being stored (Appendix H). However, no hazards or spills were noted in Building 808. No other significant problems were found in Parcel A. Observations made during subsequent visits to buildings in Parcel A, including Buildings 808 and 906, are presented in Table I-1, in Appendix I.

Also in 1988, HLA performed an investigation of the landscaped parking area in front of the Officer's Club, Building 901 (PA-19), to investigate the possible presence of soil contamination, assess whether an immediate threat to public health or the environment existed, and evaluate the need for an immediate response action (HLA 1988c). The report recommended that no immediate response action was necessary, but that additional sampling be performed.

Sanitary sewers and storm drains throughout HPA were also evaluated in 1988 in studies conducted by YEI Engineering, Inc. (YEI). The studies summarized the history of the systems and site-wide conditions, and assessed the integrity of the two systems with particular regard to their adequacy to meet existing and future needs of several Navy projects (YEI 1988a, 1988b). Although evaluating the presence of contamination in the systems was not included in YEI's scope of work, a general facility-wide reference was made to the presence of sanitary and industrial pollution within the two systems.

In 1991, PRC removed an underground storage tank, UST S-812 (Plate 2), and associated piping that once contained fuel oil for a boiler in Building 813 (PRC 1992b). Soil samples were collected from the sides of the excavation, at the water table, and along the product pipeline trench; one grab groundwater sample was obtained from the excavation. Several organic compounds were detected at low concentrations in the groundwater and soil samples. After removal of the tank, the excavation was backfilled and paved. A detailed discussion of the investigations at this site is presented in Section 4.6.

TABLE I-1

SUMMARY OF WORK PERFORMED AT PARCEL A BUILDINGS

Building # - Navy Building Title	Initial Asessment Study (Westec, 1984)	Fence-to-Fence Hazardous Material Survey (ERM-West, 1988)	PA Other Areas/Utilities (HLA, 1990)	HLA Site Inspections(i) (1991) /Response to Comments	Site Inspection Work Plan: PA Other Areas/Utilities - Volume III	Other Work
322	Not Investigated	Not Investigated	R: Not recommended for further action		Not Investigated	
805 - Guard Shelter	Not Investigated	Not Investigated	R: Not recommended for further action		Not Investigated	
808 - Storehouse	Not Investigated	C: Investigated and put on "priority tenant" table for tenant buildings. The survey noted inadequate containment and labeling of waste oils by the tenant, Precision Transport. However, " No hazards or observed problems except waste oil being stored, some in open containers" was noted. The waste oil was stored in 5- and 55-gallon drums inside the building. R: Upgrade hazardous waste management practices	R: Not recommended for further action	C: Office furniture storage/Precision Trucking company freight stroage. No apparent chemical storage or leakage observed. R: Not recommended for further action	Not Investigated	
813 - Storehouse & Offices	Not Investigated	C: Investigated and put on "priority wastes listing" table for Navy buildings. Used as offices and a storehouse by the Navy. Chemicals noted in survey were paints, solvents, flammable liquids, and oils. A transformer station was found on roof. R: Remove and characterize open bucket of oil in east elevator room	R: Not recommended for further action		C: Investigated as part of the PA-51 transformer work. No evidence of staining on or around concrete transformer pad located on top of building. R: No action	(1) UST Removal (PRC, 1992)
815 (Not Navy property)	C: Noted in text that this building was used for radiological research operations from 1955 to 1969 and that there was a small incinerator behind the building from the mid 1950s to 1970. R: Not recommended for further work	Not Investigated	R: Not recommended for further action		Not Investigated	

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
5	Removed	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.2, pages 57 and 58. PRC Environmental Management, Inc. and Harding Lawson Associates. October 15, 1993.

4.6.2 Field Investigation

In August 1991, UST S-812 was removed along with 22 other USTs that were either removed or closed in place at HPA (PRC 1992b). The field activities performed as part of the removal activities for UST S-812 included (1) tank and piping removal, (2) soil sampling, (3) groundwater sampling, and (4) backfilling and site closure, as described below.

Tank and Piping Removal

No underground utility lines adjacent to UST S-812 were identified from site maps or GPR surveys. An exclusion zone was set up in the parking lot around the tank location using traffic barricades and yellow caution tape. After securing the area, the asphalt covering UST S-812 was broken up by an excavator and placed on a double layer of 10-mil liner adjacent to the area being excavated.

Sandy backfill soil was removed from the top and sides of the UST to expose it for removal. The UST was encountered at approximately 3 feet below the asphalt surface. A surface manway (UST access hatch) extended from the top of the tank to the asphalt surface. This manway was unbolted and detached from the UST in order to transport the UST on a flatbed trailer. The UST was held in place on a concrete ballast pad by five metal straps. Groundwater was encountered at approximately 6 feet below the asphalt surface. The soil at this depth had a distinctive gray clay layer. Soil excavated from the UST S-812 excavation was placed on a liner sheeting adjacent to the excavation.

An OVA was used to monitor for organic vapors at the excavation site, with the majority of monitoring conducted in the breathing zone. During the course of removing UST S-812, from groundbreaking through excavation activities, OVA readings in the excavation and breathing zone were less than 1 ppm.

After excavating around the perimeter of UST S-812, fuel oil product piping leading from the UST to Building 813 was located. This piping was disconnected where it entered the building and was removed by pulling it loose with the excavator. No residual fuel oil was spilled from product piping. Left-in-place piping was sealed with cement grout. The removed piping was temporarily placed with piles of excavated backfill soil prior to its disposal with the UST.

The interior of UST S-812 was rinsed using hot water under high pressure to remove residual product. Prior to the rinsing operation, the tank void space was monitored using an OVA and lower explosive limit (LEL)/percent oxygen analyzer. The OVA reading in the tank prior to rinsing was 6 ppm. The LEL reading after rinsing was measured at 0 percent and the oxygen in the tank was determined to be 18 percent. The tank rinsate was pumped into a vacuum truck and transferred to an onsite storage tank adjacent to the decontamination area.

Four hours prior to removing UST S-812, 250 pounds of dry ice were placed inside the UST to displace potentially explosive gases that may have accumulated inside the UST. Two and a half hours after placing dry ice in the UST, the void space inside the UST was measured to be 1 percent of the LEL with 10 percent oxygen. At that time, three of the five straps holding the UST to its ballast pad were cut using a radial saw. The last two straps remained uncut in order to stabilize the UST until just prior to lifting the UST from the excavation. Immediately prior to pulling the UST from the excavation, the UST's void space measured to be 0 percent of the LEL and 16 percent oxygen.

UST S-812 was removed from the excavation on August 23, 1991. Ms. Cynthia Woo of the City and County of San Francisco (CCSF) observed the removal. The UST was lifted from the excavation with a crane and loaded onto a flatbed trailer for disposal offsite. The UST appeared to be in good condition with no apparent holes or corrosion pits. The steel manway and product piping associated with UST S-812 were placed in a rolloff bin for offsite disposal.

Following removal of UST S-812 from the excavation, approximately 1,300 gallons of groundwater from the excavation were pumped into a vacuum truck for transfer to a temporary storage tank. Immediately after dewatering, the excavation was prepared for soil sampling by removing sloughed soils with an excavator. After this procedure, the excavation had the following approximate dimensions: 21.8 feet wide by 36.0 feet long by 10.5 feet deep.

Soil Sampling

On August 26, 1991, soil samples were collected from the excavation in accordance with the procedures described in the removal action plan/closure plan (RAP, PRC 1990). Mr. Stanley Sun of the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) observed the sampling procedures and obtained soil samples.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
6	Backfilled and paved	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.2, pages 59 and 60. PRC Environmental Management, Inc. and Harding Lawson Associates. October 15, 1993.

collected from the product pipe trench. Sample S-812-S1 was a gray-buff colored sand with no discoloration or hydrocarbon odor present. This soil sample was collected at the north end of the UST excavation at approximately 9 feet bgs. Soil sample S-812-S2, collected at the south end of the UST excavation pit at approximately 8 feet bgs, was also gray-buff colored sand with no discoloration or hydrocarbon odor present. Sample S-812-S3 was a gray-buff colored sand with minor amounts of black shale and no discoloration or hydrocarbon odor. Samples S-812-PP1 and PP2 were collected from the product pipe trench approximately 2 feet bgs. These soil samples were a gray-buff colored sand with minor amounts of gravel and no discoloration or hydrocarbon odor.

Groundwater Sampling

Groundwater samples were obtained from a shallow pit in the northeast corner of the UST S-812 excavation. In accordance with the RAP (PRC 1990), samples were collected with a disposable bailer. Mr. Sun observed the groundwater sampling procedures.

Groundwater, present at approximately 9.5 feet bgs, was muddy with no visible floating product or hydrocarbon sheen. Groundwater was collected and groundwater sample containers were labeled as Sample S-812-GW. The groundwater sample collected was cloudy and no hydrocarbon odor or sheen was present.

Backfill and Site Closure

The bottom of the excavation was backfilled with clean fill and the asphalt debris from the parking lot that had previously covered the UST location. After consolidating the asphalt and clean fill to an even layer, the excavation was lined with a layer of 10-mil liner prior to backfilling with excavation spoils in 1- to 2-foot lifts. Each lift of backfill material was compacted using a remote-controlled compaction vehicle. Concurrent with backfilling operations, the asphalt surrounding the excavation was cut using a concrete/asphalt cutting machine. The asphalt was cut in a "squared-off" fashion surrounding the excavation in preparation for reasphalting the area. Also, the parking lot area surrounding the excavation was swept and washed clean of residual backfill soils.

The backfilled UST excavation was covered with a layer of 10-mil liner at approximately 1 foot below grade. The excavation was brought up to grade with an aggregate base.

Following backfilling activities, the parking lot was reasphalted and restriped according to its original configuration. The corners of the excavation were also marked on the newly asphalted area with white paint. Further, the corners of the excavation were surveyed from a benchmark (BM) located approximately 10.8 feet from the southeast entrance of Building 813 on a relative bearing approximately 60 degrees west towards Building 813. From the BM, the distance (in feet) and the magnetic direction (in degrees) to the four corners of the tank excavation are approximately as follows:

Excavation Corner	Distance from BM	Relative Bearing from BM
Southwest	32.7 feet	250°
Southeast	47.5 feet	247°
Northeast	53.4 feet	211°
Northwest	41.1 feet	201°

4.6.3 Summary of Results

The analytical results for the five soil samples and one groundwater sample are as follows.

Soil

Five soil samples were collected and analyzed for metal compounds, SOCs, VOCs, PCBs, pesticides, and TPH. Analytical results are included in Appendix D. Concentrations of metal compounds detected were all below the IALs. Sample S-812-S3 was the only sample to contain an SOC (phenanthrene at 190 μg/kg). The only VOC detected was total xylene (5 μg/kg) in Sample S-812-S1. No PCBs or pesticides were detected in the five soil samples collected at the UST site. Diesel was the only TPH compound detected in the five soil samples. Sample S-812-S3, collected from the UST excavation, contained TPHd at 14 mg/kg. The product pipe samples contained TPHd at levels ranging from 18 to 32 mg/kg.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
7	Results	Section 2.3	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 4.6.3, pages 60 to 61. PRC Environmental Management, Inc. and Harding Lawson Associates. October 15, 1993.

Following backfilling activities, the parking lot was reasphalted and restriped according to its original configuration. The corners of the excavation were also marked on the newly asphalted area with white paint. Further, the corners of the excavation were surveyed from a benchmark (BM) located approximately 10.8 feet from the southeast entrance of Building 813 on a relative bearing approximately 60 degrees west towards Building 813. From the BM, the distance (in feet) and the magnetic direction (in degrees) to the four corners of the tank excavation are approximately as follows:

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Groundwater

The groundwater sample collected from the excavation was analyzed for metal compounds, SOCs, VOCs, PCBs, pesticides, and TPH. Analytical results are included in Appendix D. Metals that exceed the established background levels included aluminum, arsenic, beryllium, chromium, cobalt, copper, iron, lead, nickel, vanadium, and zinc; the elevated levels of metals are most likely due to sampling problems such as filter breakthrough; the sample was noted as being cloudy. No SOCs, PCBs, or pesticides were detected in the groundwater sample collected at this tank site. Seven VOCs (benzene, 1,2-dichloroethane, 1,1-dichloroethene, tetrachloroethene, 1,1,1-trichloroethane, PCE, and toluene) were detected at concentrations ranging from 3 to 6 μg/L. No TPH constituents were detected in the groundwater sample collected at this tank site.

4.6.4 Evaluation and Discussion

Low levels of VOCs and SOCs were detected in the soil samples collected from the excavation. The TPHd detected in the excavation and product pipe trench samples are considered low and are below the RWQCB's cleanup goal of 100 ppm, which has been commonly used at other UST sites.

UST S-812 does not appear to have contributed to the contamination of groundwater at this site. The volatile compounds detected in the groundwater are not consistent with its historical tank contents. Because substantial soil and groundwater contamination were not found at the UST S-812 site and because the site has been backfilled and paved (therefore providing no direct exposure), no human health risk calculation was performed for this site. Additional work is currently being conducted to confirm the VOCs detected in the groundwater at this site. The results will be presented as an addendum to this draft final report.

5.0 POTENTIAL MIGRATION PATHWAYS

Conceptually, the potential chemical migration pathways in Parcel A include the movement of chemicals in air, surface water, and groundwater. Migration pathways are influenced by physical and chemical properties of the constituents of concern and site characteristics such as topography, geology, hydrology, and meteorology.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
8	Regulatory agency concerns	Section 2.3	Draft Report of Results for Work Plan Addendum No. 4, Parcel A Site Inspection Report, Hunters Point Annex, San Francisco, California. Section 1.0, page 1. Harding Lawson Associates. October 29, 1993.

1.0 INTRODUCTION

This report presents the results of the additional investigation at the former underground storage tank (UST) S-812 site in Parcel A, Hunters Point Annex (HPA), San Francisco, California (Plate 1). Harding Lawson Associates (HLA) performed the investigation under Work Plan Addendum No. 4 *(PRC, 1993b)* to the Site Inspection Work Plan: PA Other Areas/Utilities (*HLA, 1992a,b,c*) and the Removal Action/Tank Abandonment Plan (*PRC, 1990*). Site inspection (SI) activities at HPA are being performed in accordance with these planning documents, as modified by work plan addenda and field variances.

The purpose of this additional investigation was to address agency concerns regarding the potential occurrence of trace volatile organic compounds (VOCs) detected in soil and groundwater samples at UST S-812 during the tank removal.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
9	Basewide HRA	Section 2.3	Final Historical Radiological Assessment, History of the Use of General Radioactive Materials, 1939 – 2003. Section 8.3.4.18 and Figure 8.3.4.18, pages 8-129 to 8-131. Naval Sea Systems Command. October 2004.

8.3.4.18 Building 813

Site Description: A large, 262-by-262-foot, four-story reinforced concrete, flat-roofed warehouse that includes banks of industrial steel sash in horizontal bands across all four stories, except at the front (south) of the first floor. The front has a bank of steel roll-up industrial doors extending the length of the concrete loading dock area. The loading dock is sheltered by a concrete canopy **(HRA-1118, pp 70-71)**. Figure 8.3.4.18 provides a map of the site location.

Former Uses: General warehouse and offices, supply storehouse **(HRA-1118, p 70)**, and Disaster Control Center **(HRA-1481; HRA-2829).**

Current Uses: Unoccupied.

Radionuclides of Concern: Sr-90 **(HRA-2829)**.

Previous Radiological Investigations: None.

Contamination Potential: Unlikely. A leaking 300-µCi Sr-90 check source was found in the Disaster Control inventory, and the Disaster Control Center was located in Building 813; however, spread of contamination from this source would be unlikely **(HRA-2829).**

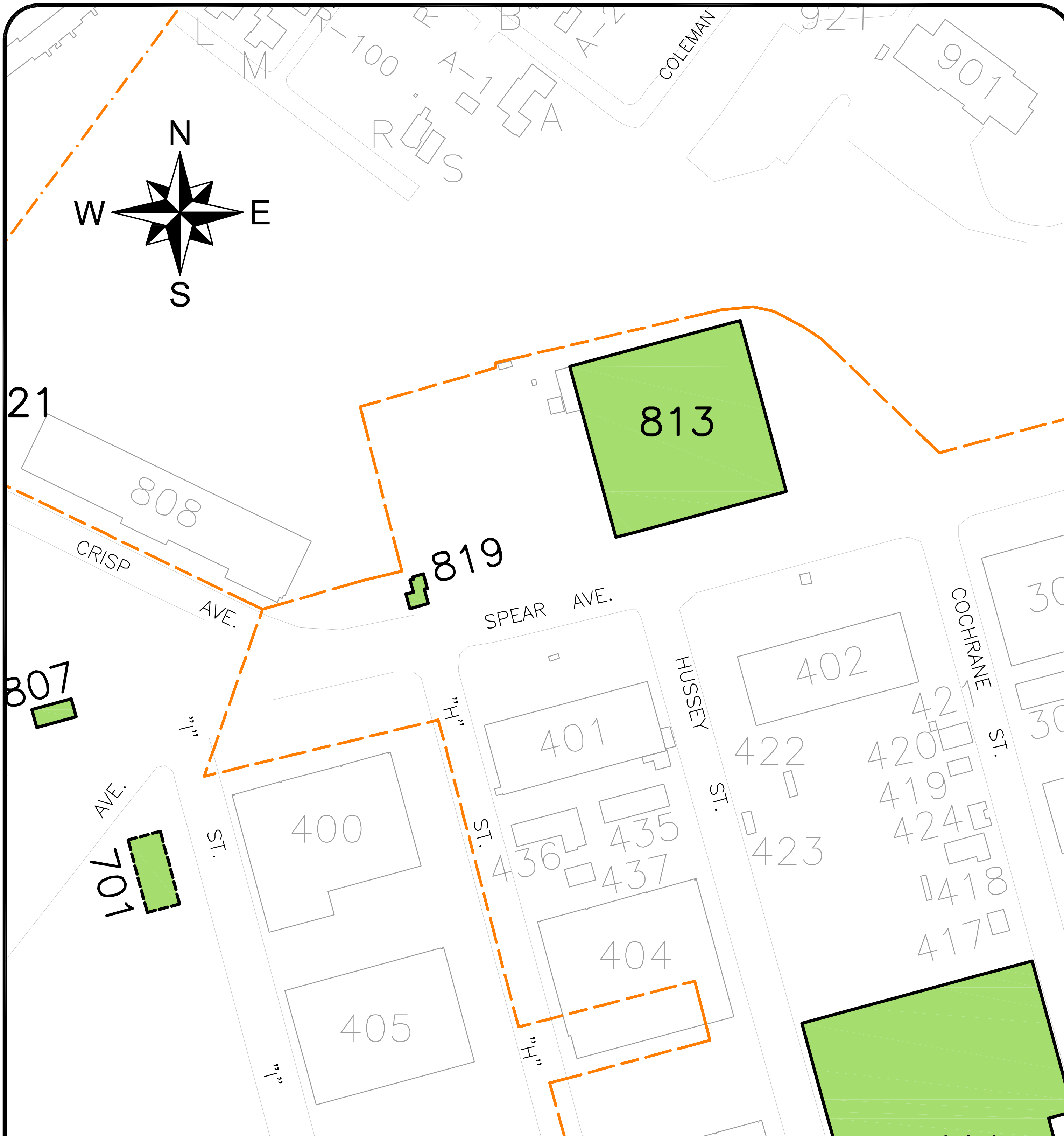
Contaminated Media:

Surface Soil: None
Subsurface Soil: None
Sediment: None
Surface Water: None
Groundwater: None
Air: None
Structures: Low
Drainage Systems: None

Potential Migration Pathways:

Surface Soil: None
Subsurface Soil: None
Sediment: None
Surface Water: None
Groundwater: None
Air: None
Structures: Low
Drainage Systems: None

Recommended Actions: Scoping Survey. Characterization Survey if contamination identified. Final Status Survey if no contamination is identified.



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Scale in Feet

- Impacted Site with Designation
- Impacted Site with Designation (Demolished)
- IR Site w/ Designation
- Non - Impacted Building
- Non-Impacted Building (Demolished)
- Topographic Feature
- Parcel Boundary

Hunters Point Naval Shipyard
San Francisco CA
Historical Radiological Assessment

Bldg. 813 and 819 Site Plan

August, 2004

Figure 8.3.4.18

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
10	Potential radiological contamination	Section 2.3	Final Historical Radiological Assessment, History of the Use of General Radioactive Materials, 1939 – 2003. Table 8-2, page 5 of 11. Naval Sea Systems Command. October 2004.

TABLE 8-2
BUILDING/AREA ASSESSMENT AND CLASSIFICATION

Building No. or Area	Contamination Potential					Contaminated Media								Potential Migration Pathways								Radionuclides of Concern and Recommended Actions
	Known Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Sediment	Surface Water	Ground Water	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Sediment	Surface Water	Ground Water	Air	Structures	Drainage System	
Parcel D (Continued)																						
408			✓			N	N	N	N	N	N	M	N	N	N	N	N	N	N	L	N	Ra-226, Natural Uranium (Firebrick) Scoping Survey
411				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N	Co-60, Cs-137, Ra-226 Review Final Status Survey Report
Gun Mole Pier			✓			L	L	L	N	N	N	L	L	L	L	L	N	N	N	L	L	Cs-137, Pu-239, Ra-226, Sr-90 Review Characterization Report
500				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N	Cs-137, Ra-226 Scoping Survey
503 Site			✓			N	L	L	N	N	N	N	L	N	L	L	N	N	N	N	L	Cs-137, Ra-226, Sr-90 Scoping Survey
Mahan Street-NRDL			✓			M	M	N	N	N	N	N	N	L	L	N	N	N	N	N	N	Cs-137, Pu-239, Ra-226, Sr-90 Review Final Status Survey Report
813				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N	Sr-90 Scoping Survey
819			✓			N	L	M	N	N	N	L	M	N	L	M	N	N	N	L	M	Cs-137, Ra-226 Scoping Survey
Parcel E																						
406			✓			N	N	N	N	N	N	M	N	N	N	N	N	N	N	L	N	Cs-137, Ra-226 Review Final Status Survey Report
414				✓		N	N	N	N	N	N	L	N	N	N	N	N	N	N	L	N	Ra-226 Review Final Status Survey Report

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
11	Boundary	Section 2.3	Final Finding of Suitability to Transfer for Parcel A (Revision 3), Hunters Point Shipyard, San Francisco, California. Section 2.0, pages 5 and 6. Tetra Tech EM Inc. October 14, 2004.

- Navy. 2002. Letter Regarding Release of Building 821, Parcel A, at HPS. June 12.
- CaDHS Environmental Management Branch. 2002. Letter Regarding Release of Building 821, Parcel A at HPS. November 15.
- TtEMI. 2003. "Final Landfill Gas Characterization Report, Parcel E Nonstandard Data Gaps Investigation, HPS, San Francisco, California." December 23.
- RASO. 2004. "Final Historical Radiological Assessment [HRA], History of the Use of General Radioactive Materials, 1939-2003, HPS, San Francisco, California." Volume II. August 31.
- TtEMI. 2004. "Parcel E Standard Data Gaps Investigation, Interim Data Analysis Report, HPS, San Francisco, California." March 10.
- EPA. 2004. Electronic Mail Regarding HPNS [Hunters Point Naval Shipyard] Building 322 Radiation Confirmation Survey Results. From Mr. Steve M. Dean, Superfund Technical Support, EPA. To Michael Work, DOD and Pacific Islands Section, EPA. July 14.
- Tetra Tech FW, Inc. 2004. "Final Status Survey and Results, Revision 0, Building 322 (Donahue Street and Innes Avenue), HPS, San Francisco, California." July 27.
- CaDHS Environmental Management Branch 2004. Letter Regarding Release of Building 322, Parcel A, at HPS. August 27.

2.0 PROPERTY DESCRIPTION

HPS is located on a promontory in southeastern San Francisco (Figure 1). Parcel A consists of 75 acres of land at HPS. Currently, 74 buildings are present on Parcel A, 45 of which are former residences. Table 1 lists the buildings in Parcel A. In addition to the 74 buildings, the foundations of 43 former structures are located in Parcel A. Parcel A also contains storm drains, steam lines, a sanitary sewer system, and an active natural gas distribution system that served or serves Buildings 322 (former), 915, and 916.

Parcel A is bounded by Parcels B, C, D, and E, and by the Bayview-Hunters Point neighborhood to the northwest. The boundaries of Parcel A are shown on Figure 2. The boundary of Parcel A has been revised several times since it was originally delineated in 1992. Before the record of decision (ROD) for Parcel A was completed in 1995, the boundary of the parcel was modified to keep the contaminated areas intact. The parcel as originally delineated was modified in two areas along the common boundaries between Parcels A and B at Installation Restoration (IR) Sites 06 and 18. As a result, Parcel B now includes areas where contaminants were detected along the boundary of Parcel A; in other words, the contaminated areas are now completely within Parcel B. The boundary of Parcel A as published in the ROD reflected this change (PRC 1995b). In addition, the entirety of IR-06, previously located in Parcel B, was moved to Parcel C in 2001.

In October 1998, the boundary of Parcel A was further modified, as shown on Figure 2. The portion of Crisp Avenue that was previously part of Parcel A has been excluded and is now part of Parcel E. In addition, the boundary of Parcel A was modified to include the portion of Spear Avenue that lies along the southeastern border of the parcel.

In 2002, the boundary of Parcel A was again revised, as shown on Figure 3. The northwestern boundary of Parcel A was modified to exclude an area adjacent to Parcel B; this area will be addressed in the future as part of Parcel B. It was moved because of its proximity to locations at Parcel B that underwent remediation from 1998 to 2001. During the remedial action at Parcel B, one excavation extended into Parcel A, and one excavation was near the boundary of Parcel A. The excavations were backfilled with clean soil after results for confirmation samples were found to meet the cleanup goals for residential reuse. However, because the regulatory agencies had not yet reviewed the data for the completed excavations, the boundary of Parcel A was modified to (1) move both excavations completely into Parcel B, and (2) include a buffer zone at least 20 feet wide between each excavation and the boundary of Parcel A. In addition, the boundary of Parcel A was modified to include the portion of Fisher Avenue that lies along the eastern border of the parcel.

In 2004, the boundary of Parcel A was again revised, as shown on Figure 2. In addition to removing portions of Spear and Fisher Avenues from Parcel A (rescinding the 1988 and 2002 modifications, respectively), the southeastern boundary of Parcel A was modified to exclude Buildings 813, 819 (Sewer Pump Station “A”), and 823 and the surrounding area. This area now lies in Parcel D. It was moved based on the recommendation in the HRA (RASO 2004) that Buildings 813 and 819 be surveyed for potential radioactive contamination. A survey was also recommended for the main line of the sanitary sewer along Fisher and Spear Avenues that flows into the pump station and the main line along Crisp Avenue that flows out of the pump station.

In addition, boundaries of EBS subparcels N1A, S46A, and H48A have been revised, as shown on Figure 3, to eliminate the minor discrepancies between the boundaries of the subparcels in the EBS and the boundary of Parcel A. Small areas of Parcel A have been shown outside of EBS subparcel boundaries because those boundaries were established during the original EBS based on computer-aided design drawings of the base. Conversely, the boundary of Parcel A was delineated directly from legal descriptions. Since Parcel A accurately represents the actual extent of Navy-owned property, the boundaries of the subparcels in the EBS were revised to be contiguous with the boundary of Parcel A.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
12	Released	Section 2.3	Final Status Survey Results, Building 813, Hunters Point Shipyard, San Francisco, California. Section 11.0. Tetra Tech EC, Inc. September 12, 2007.

11.0 CONCLUSION

Building 813 is a large, 262-by-262-foot, four-story reinforced concrete, flat-roofed supply warehouse with banks of industrial steel sash in horizontal bands across all four stories, except at the front of the first floor on the south end of the building. The front has a bank of steel roll-up industrial doors extending the length of a concrete loading dock area sheltered by a concrete canopy.

Historical documents indicate that a leaking check source of 300 µCi of ^{90}Sr was discovered during routine swipes of the check sources. The historical documentation does not indicate if the leaking source contaminated the DCC work spaces. Additionally, during a walkthrough of Building 813, a cabinet with a radioactive materials placard was found on the first floor. There was no indication of what types of radioactive materials may have been stored in the cabinet. No other physical indications of the presence of radioactive materials were found in any location in Building 813.

In addition to identifying ^{90}Sr as a radionuclide of concern (ROC), ^{137}Cs and ^{226}Ra were included as ROCs for the scoping survey of Building 813. These ROCs were chosen as they were commonly used throughout HPS, and with ^{90}Sr, will cover alpha, beta, and gamma radiation.

After reviewing the applicable plans of Building 813, Building 258 was selected as the appropriate reference area. Building 258 has no radiological history, is made of similar building materials, and was constructed in the same era as Building 813.

In summer 2006, NWT, a radiological services subcontractor to TtEC, performed a scoping survey to determine if contamination exists on the first floor of Building 813. While not initially designated as an FSS, the scoping survey was designed so it could be used as an FSS, in accordance with the MARSSIM (NUREG-1575; Department of Defense et al., 2000), if no contamination was found. To perform the survey, the first floor of Building 813 was divided into 18 Class 1 survey units, two Class 2 survey units, and one Class 3 survey unit. The floors and walls less than or equal to two meters above the respective floor areas around the previous location of the DCC were divided into Class 1 survey units. Areas that surrounded the Class 1 survey units were divided into Class 2 survey units. The Class 3 survey unit encompassed the remaining portions of the first floor outward of the Class 2 survey units.

Survey methods included fixed static (direct) and scan surface contamination surveys for alpha and beta radiation, and static and scan measurements were performed for gamma radiation. Exposure rate measurements were performed at static reading locations. Additionally, swipe samples were obtained to evaluate the presence of loose alpha and beta-gamma radiation at static reading locations.

The analysis of collected field data shows that the residual radioactivity at Building 813 meets the stated release criteria and that Building 813 is ready for unconditional unrestricted use.

Since the mean concentrations for both alpha and beta emitters were less than zero, each survey unit (and thusly the entirety of Building 819) is assigned an administrative dose of 0.00 millirem per year. No further dose modeling was determined to be necessary.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
13	Unrestricted use	Section 2.3	Recommendation for Unrestricted Release for Building 813 and Building 819, Hunters Point Shipyard, San Francisco, California. Letter from Thomas P. Lanphar, DTSC. To Keith Forman, Department of the Navy. April 14, 2008.

Department of Toxic Substances Control

Maureen F. Gorsen, Director
700 Heinz Avenue
Berkeley, California 94710-2721

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

April 14, 2008

Department of the Navy
Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310
Attention: Keith Forman

RECOMMENDATION FOR UNRESTRICTED RELEASE FOR BUILDING 813 AND BUILDING 819, HUNTERS POING SHIPYARD, SAN FRANCISCO, CALIFORINA

Dear Mr. Forman:

In support of an interagency agreement between DTSC and the California Department of Public Health, Environmental Management Branch (CDPH), CDPH has reviewed documents associated with radiological issues regarding Building 819 and Building 813 and performed confirmation surveys of these buildings. CDPH has concluded that, with respect to radiological issues, these buildings are acceptable for unrestricted release. Letters from CDPH to DTSC regarding their concurrence for unrestricted release of the buildings are attached to this letter.

If you have any questions regarding this letter, please call me at 510-540-3776.

Sincerely,

Thomas P. Lanphar
Senior Scientist
Office Military Facilities
Department of Toxic Substances Control

cc: See next page.

cc: Mr. Mark Ripperda
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Mr. Erich Simon
Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, California 94612

Penny Leinwander
Department of Health Services
Environmental Management Branch
P.O. Box 997413, MS 7405
Sacramento, California 95899-7413

cc: VIA EMAIL

Ms. Amy Brownell
City of San Francisco

Ms. Karla Brasaemle
Tech Law, Inc.

Ms. Barbara Bushnell
Hunters Point Restoration Advisory Board

Mr. Steve Hall
Tetra Tech EMI

Ms. Melanie Kito
US Navy

Ms. Vandana Kohli
California Department of Public Health

Mr. Leon Muhammad
Hunters Point Restoration Advisory Board
Community Co-Chair

Mr. Ralph Pearce
US Navy

Diane Wesley Smith
Community Resident

Dr. Ray Tompkins
Hunters Point Restoration Advisory Board

CDPH
PublicHealth

California Department of Public Health
MEMORANDUM

DATE: April 1, 2008

TO: Mr. Rick Moss, Chief
Office of Military Facilities
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, California 95826-3200

FROM: Robin R. Hook, Chief
Environmental Management Branch
P.O. Box 997413
1616 Capitol Avenue, MS 7405
Sacramento, California 95899-7413
(916) 449-5667

SUBJECT: Recommendation for Unrestricted Release of Building 813 at former Hunters Point Naval Shipyard, San Francisco, California.

Upon the request of the Department of Toxic Substance Control (DTSC), the Environmental Management Branch (EMB), California Department of Public Health (CDPH) reviewed documents associated with radiological issues regarding Building 813 and performed confirmation surveys of this building. EMB has concluded that, with respect to radiological issues, this building is acceptable for unrestricted release.

If you need further assistance please contact Penny Leinwander of my staff at (916) 449-5921.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
14	Groundwater	Section 2.4	Record of Decision for Parcel A, Hunters Point Annex, San Francisco, California. Section 2.6.1, Page 17. Department of the Navy, EFA WEST, San Bruno, California. November 16, 1995.

site facility, and confirmation samples were collected and tested using an EPA-approved immunoassay-based test method. Soil excavation and confirmation sampling continued until field testing resulted in pesticide concentrations below the detection limit. In addition, samples were sent to a laboratory and analyzed for SVOCs, pesticides, PCBs, TPH as motor oil and diesel, and metals. Soil excavated during the investigation was replaced with clean soil. Tables 3, 4, and 5 summarize data on the compounds in soil after the completion of the investigation. A comprehensive discussion of the soil investigation and the nature and extent of compounds detected in soil is presented in the Parcel A RI report (PRC 1995b).

2.6 SUMMARY OF SITE RISKS

2.6.1 Human Health Risk Assessment

During the RI, the Navy considered the potential human health risks associated with sites IR-59 and IR-59 JAI. The RI risk analysis is described below.

Human exposure to groundwater at Parcel A is highly unlikely for the following reasons:

- Parcel A groundwater is present only in limited fractures or in poorly interconnected and sporadic fractures in the bedrock.
- In areas where groundwater was detected, individual wells are capable of yielding only insignificant and nonsustainable quantities of water.
- Historical records confirm that groundwater in Parcel A bedrock has never been used as a source of drinking water.
- The City of San Francisco's current groundwater policy excludes groundwater in Parcel A bedrock from future development based on the distribution of water in the bedrock and its characteristics.

For these reasons, there is no complete pathway for exposure to groundwater. Based on this fact and the fact that CERCLA-regulated substances were not detected above PRGs, no human health risk assessment (HHRA) for exposure to groundwater was performed. EPA and Cal/EPA concur that an HHRA for groundwater is unnecessary (EPA 1995b).

During the investigation, soil and sandblast grit were excavated and disposed of at an approved off-site facility, and confirmation samples were collected and tested using an EPA-approved immunoassay-based test method. Soil excavation and confirmation sampling continued until field testing resulted in pesticide concentrations below the detection limit. In addition, samples were sent to a laboratory and analyzed for SVOCs, pesticides, PCBs, TPH as motor oil and diesel, and metals. Soil excavated during the investigation was replaced with clean soil. Tables 3, 4, and 5 summarize data on the compounds in soil after the completion of the investigation. A comprehensive discussion of the soil investigation and the nature and extent of compounds detected in soil is presented in the Parcel A RI report (PRC 1995b).

2.6 SUMMARY OF SITE RISKS

2.6.1 Human Health Risk Assessment

During the RI, the Navy considered the potential human health risks associated with sites IR-59 and IR-59 JAI. The RI risk analysis is described below.

Human exposure to groundwater at Parcel A is highly unlikely for the following reasons:

- Parcel A groundwater is present only in limited fractures or in poorly interconnected and sporadic fractures in the bedrock.
- In areas where groundwater was detected, individual wells are capable of yielding only insignificant and nonsustainable quantities of water.
- Historical records confirm that groundwater in Parcel A bedrock has never been used as a source of drinking water.
- The City of San Francisco's current groundwater policy excludes groundwater in Parcel A bedrock from future development based on the distribution of water in the bedrock and its characteristics.

For these reasons, there is no complete pathway for exposure to groundwater. Based on this fact and the fact that CERCLA-regulated substances were not detected above PRGs, no human health risk assessment (HHRA) for exposure to groundwater was performed. EPA and Cal/EPA concur that an HHRA for groundwater is unnecessary (EPA 1995b).

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
15	Risk	Section 2.5	Site Inspection Report for Parcel A, Hunters Point Shipyard, San Francisco, California. Section 6.0, page 64. PRC Environmental Management, Inc. and Harding Lawson Associates. October 15, 1993.

The objective of the risk assessment was to evaluate the potential health risks posed by contaminants detected at the Parcel A sites and to evaluate the need for a removal or interim remedial action. A risk assessment was performed for only those sites in Parcel A that were considered to pose potential health risks. Those sites were PA-19, PA-41, PA-43, and the PA-50 sanitary sewers. The risk assessment consisted of: (1) sample-by-sample review of environmental analytical data; (2) statistical analysis; (3) development of reference concentrations, such as health-based levels (HBL) for soils following the methodology for the Alternative Selection Reports (ASR) prepared for HPA; and (4) assessment of the human health risks using the HBLs and evaluation of the need for cleanup action.

No human health risk calculations were performed for PA-45 (steam lines), the PA-50 storm drains, nor PA-51 (transformer locations), because based on an evaluation of the SI data, these sites are not expected to pose any significant health risks. Similarly, no human health risks were calculated for the former UST S-812 because no substantial soil or groundwater contamination was found and because the site has been backfilled and paved (therefore providing no direct exposure).

The following sections summarize the procedures and assumptions used in performing the risk assessment, followed by a summary of the risk assessment results for PA-19, PA-41, PA-43, and the PA-50 sanitary sewers. Details of the risk assessment for these sites may be found in Appendix F. Finally, a qualitative assessment of potential hazards to ecological receptors from chemicals detected in Parcel A is presented in this section.

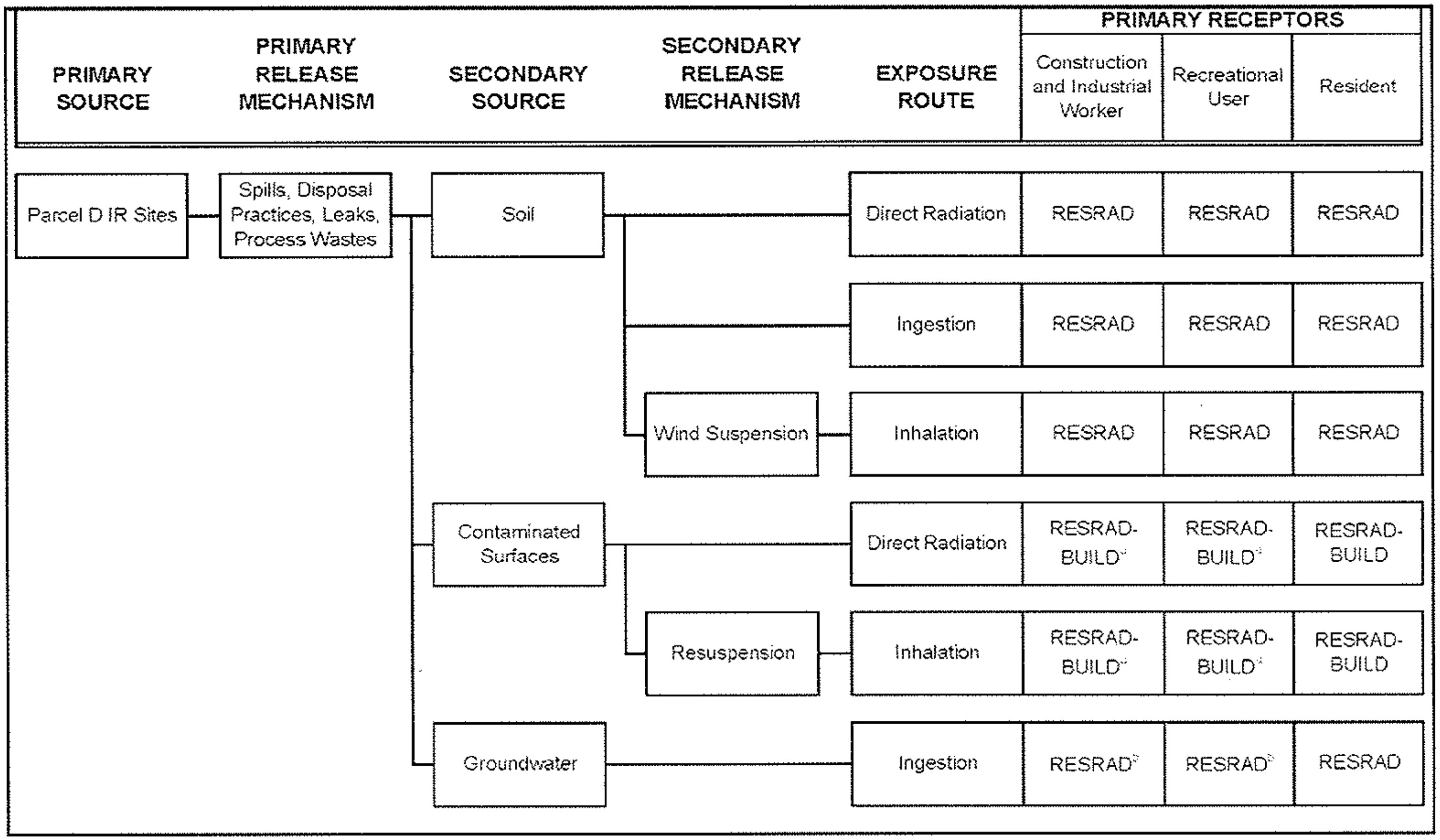
6.1 RISK ASSESSMENT PROCEDURES AND ASSUMPTIONS

Currently, there are few civilian and military personnel working within the Parcel A boundaries. The likelihood of daily exposure to contaminants detected within the contaminated areas at Parcel A is extremely low. Nevertheless, potential reasonable maximum exposure (RME) risks posed by all detected chemicals, including IAL metals, were calculated based on possible future land uses and assuming daily contact to the contaminated soil. As recommended by the regulatory agencies in a meeting with the Navy on September 18, 1992, HBLs for soil (Appendix F) were used as reference concentrations to evaluate risks associated with measured site concentrations. Potential future land

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
16	Conceptual site model	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Figure A.3-1. Tetra Tech EC, Inc. April 11, 2008.

FIGURE A.3-1

CONCEPTUAL SITE MODEL



Notes:

a Resident scenario bounds the worker and recreational user scenarios
b Per agreement with Base Closure Team

Abbreviations and Acronyms:

IR – Installation Restoration
N/A – not applicable

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
17	Radiological risk	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Section 2.0, pages A.2-1 through A.2-5. Tetra Tech EC, Inc. April 11, 2008.

2.0 RADIOLOGICAL RISK ASSESSMENT METHODOLOGY

The computer codes Residual Radioactivity (Model) (RESRAD) (Department of Defense [DoD], et al., 2000) and Residual Radioactivity-Building (RESRAD-BUILD) (Nuclear Regulatory Commission [NRC], 2000) were used to perform dose and risk modeling of radiologically-impacted sites at Parcel D. RESRAD-BUILD was used to model the impacted buildings (i.e., 274, 351, 351A, 364, 365, 366/351B, 383, 401, 408, and 411. RESRAD was used to model the risk associated with impacted land areas (e.g., former building sites 313, 313A, 317, and 322) and fill areas (e.g., Gun Mole Pier and the Naval Radiological Defense Laboratory Site on Mahan Street). Both RESRAD and RESRAD-BUILD use the isotopes specified as radionuclides of interest and automatically include the long-lived daughter products of these isotopes.

RESRAD and RESRAD-BUILD were used to analyze the exposure scenarios that match planned reuse (San Francisco Redevelopment Agency, 1997). The majority of the input parameters for both RESRAD and RESRAD-BUILD were left as default except where noted. Based upon the results for a critical receptor scenario analysis, all results were run using the bounding resident adult scenario. The following paragraphs apply only to the critical receptor analysis; as noted above, all calculations used for dose and additive risk were run using RESRAD defaults.

The following discussion identifies the best processes to match each of the receptor-specific parameters for FS for Parcel D non-radiological risk and RESRAD analyses. Unfortunately, due to the manner in which indoor and outdoor fractions are used in RESRAD and how they relate to exposure time and frequency as used in the Revised FS for Parcel D, it is impossible to implement all the steps necessary to perform a completely matching calculation.

The difficulty arises from the fact that the RESRAD indoor and outdoor fractions are pervasive across all calculations. Inhalation, soil ingestion, and exposure calculations all use the indoor and outdoor fractions. Inhalation and soil ingestion rates input into RESRAD are total annual rates regardless of location on or off site, whereas rates in the Revised FS for Parcel D correspond to rates only for time spent on site. There are no indications as to what the receptor does off site in the Revised FS for Parcel D. In order to match the total intake quantities (air or soil) either the intake rates or the total on-site fraction must be modified in RESRAD. In order to match the exposure period, the only mechanism available for RESRAD is to adjust the total on-site fraction. Therefore, when matching intake quantities, the preferential method is to modify the intake rates since changes to the on-site fraction would prohibit effective matching of exposure period.

As noted in Section 2.1.5 regarding the inhalation rate, there are cases where the required changes to the intake values would put a parameter outside of RESRAD's accepted range of values for that parameter. In order to estimate the significance of this limitation, scoping calculations were performed using RESRAD default parameters, a worst-case source term with all ROCs in Parcel D present at release limits and the appropriate pathways active. The results of this analysis indicated that at 1,000 years, greater than 95 percent of the dose (with a peak of almost 97 percent at time zero) is due to direct radiation. The second highest contributor ranging from 2.0 to 2.9 percent is from soil ingestion, while inhalation ranges from 1.1 to 1.7 percent of the total dose. Fortunately, the cases where the intake parameters are outside of the RESRAD limits apply only for inhalation rates for the construction and industrial workers. Since the resident adult scenario bounds all exposure scenarios, it was used for combined risk assessments. Thus there are virtually no consequences of having to set the inhalation rate lower than the value needed to give an exact match with the Revised FS for Parcel D in these cases.

Table A.2-1 summarizes changes to RESRAD default parameters necessary to make the receptor scenarios more closely match the Revised FS for Parcel D cases. All other RESRAD parameters were left at default values. The approach taken with comparable Revised FS for Parcel D parameters is described in the following sections of this appendix.

2.1 RESRAD

The RESRAD (NRC, 2000) code is used to estimate the potential risk to an individual from exposure to residual radionuclides in soil or soil-like media. It was used to evaluate the risk associated with impacted soil areas in Parcel D. Site specific results were modeled using default RESRAD parameters for all values except for contaminated area size as noted in Section 5.2.

When looking at various receptor scenarios, the goal of the RESRAD risk modeling approach was to be as consistent as possible with assumptions and inputs used in the Revised FS for Parcel D non-radiological human health risk assessment. To achieve this goal the development of representative parameters for receptor scenarios other than the RESRAD default was required. This was achieved by following the guidance of the EPA Exposure Factors Handbook and the Risk Assessment Guidance for Superfund (RAGS) documents. These guides were also used in development of input parameters for the Revised FS for Parcel D human health risk assessment. Receptor-specific RESRAD values were selected from these documents for recreational, construction, and industrial users in addition to the default resident values. The simplest approach to modeling these scenarios would have been to simply use the values suggested by previous researchers for the various RESRAD receptor types. However, the basis of the receptors defined in the Revised FS for Parcel D are not based upon the same assumptions used in developing the RESRAD receptor types. In order to achieve the best correlation it was necessary to adjust each of the parameters based upon receptor-specific information.

The differences between the parameters for the various receptors essentially are limited to variation among:

- Averaging time for noncarcinogens
- Body weight

- Body surface area
- Exposure duration
- Exposure frequency
- Exposure time
- Inhalation rate
- Soil adherence factor
- Soil ingestion rate

The following section provides an evaluation of the sensitivity of each of these parameters when used in performing calculations with RESRAD that directly parallel the exposure scenarios defined in the Revised FS for Parcel D. This evaluation presents the chemical analysis parameter(s) and indicates the equivalent RESRAD parameter(s). Where possible, like parameters are grouped together.

2.1.1 Averaging Time for Non-Carcinogens and Body Weight

From a chemical analysis standpoint the averaging times are used to distribute the harmful effects of exposure for means of common comparison. EPA guidance assumes that all doses are essentially normalized into an average daily dose. By use of an averaging time, a long-term low dose is just as unfavorable as a short-term high dose. Body weight is a necessary component in order to obtain doses in terms of milligrams per kilogram of body weight per day.

When performing radiological calculations, however, neither one of these factors is included in risk determination. This guidance is given explicitly in Chapter 10 of the RAGS document. The rationale is that the determination of dose conversion factors for radionuclide exposure is performed in a different manner than slope factors for chemical exposure. In essence the body weight and averaging time factors are already included or unnecessary because of the manner in which the dose conversion factor calculations are performed. Therefore, consistency between the averaging time and receptor body weight parameters in the Revised FS for Parcel D and RESRAD is not necessary.

2.1.2 Body Surface Area and Soil Adherence Factor

The body surface area parameter is used in chemical analysis for the dermal contact pathway. Since radiological analysis does not have a direct contact pathway, there is no corresponding body surface area parameter. Any exposure resulting from direct contact with radiologically contaminated material would be accounted for in the external radiation pathway.

2.1.3 Exposure Frequency and Exposure Time

The exposure frequency and time are used in Revised FS for Parcel D analysis to define the exposure for the various receptors. The exposure time gives the number of hours per day that a receptor is on site and exposed to harmful substances. Exposure frequency specifies the number of days per year that a receptor is at the site. The product of the exposure time and exposure frequency yields the total number of hours spent on site in a year. For purposes of this discussion, this product shall be referred to as the exposure period.

There are no directly correlated exposure frequency or time parameters in RESRAD. Rather than using these factors explicitly, RESRAD uses parameters for indoor fraction and outdoor fraction. The former accounts for time spent inside a building at the site while the latter accounts for time on site but outside. When added together these two values give the total on-site fraction. The primary difference between time indoors and time outdoors from a calculational standpoint is that indoor time accounts for additional shielding from direct radiation offered by the building's materials. In order to be conservative, however, the total on-site fraction is allocated to the outdoor time fraction since the resulting doses are higher, resulting in a high risk number.

The indoor and outdoor fractions are unitless parameters and thus can be applied across any given time period. Using the RESRAD default indoor and outdoor fractions of 0.5 and 0.25, respectively, a default RESRAD receptor spends 18 hours per day on site. RESRAD uses a 365-day-year and there is no means of adjusting the number of days per year. Therefore, the default receptor spends a total time of 6,570 hours on site a year.

In order to match the exposure frequency in the Revised FS for Parcel D, the total on-site fraction is adjusted such that the exposure period (total number of hours of exposure per year) is consistent with the parameters from the Revised FS for Parcel D. The technique of matching total annual hours on site is consistent with suggestions given in the RESRAD manual for modeling receptors with exposure scenarios different from the default receptor.

2.1.4 Exposure Duration

The exposure duration indicates how many total years the receptor will spend on site. By default RESRAD uses a value of 30 years for exposure duration. This parameter is directly modifiable by the user. The Parcel D Revised FS uses values of 1, 6, 24, and 25 years based upon receptor type and age.

2.1.5 Inhalation Rate

The Revised FS for Parcel D analysis uses inhalation rates based upon the receptor scenario and age. Inhalation rates in the Revised FS for Parcel D are given in terms of cubic meters per hour. RESRAD has a user-defined inhalation rate that by default is 8,400 cubic meters per year (m^3/yr). RESRAD contains specialized templates for recreational and industrial workers with inhalation rates of 14,000 m^3/yr and 11,400 m^3/yr, respectively. If the Revised FS for Parcel D inhalation rates are converted to the same units used in RESRAD, rates of 3,679 m^3/yr, 7,270 m^3/yr, and 21,900 m^3/yr are obtained.

At first it would appear that simply using the converted Revised FS for Parcel D rates in RESRAD analyses would yield the desired results. Unfortunately, RESRAD has a maximum annual inhalation rate of 20,000 m^3/yr. This limitation prevented direct matching of the 21,900 m^3/yr rate used in certain Revised FS for Parcel D cases. The actual modeled values for the various receptors analyzed are presented in Table A.2-1. Since the inhalation pathway is not a critical pathway for risk, the difference in the annual breathing rate does not yield a significant difference in the estimated risk (as indicated by the fraction of total risk in Table A.5-5).

2.1.6 Soil Ingestion Rate

Soil ingestion rates in the Revised FS for Parcel D are given in terms of milligrams of soil per day. RESRAD uses soil ingestion rates in terms of grams of soil per year with a default value of 36.5 grams per year. Similarly to the inhalation rate, the best match is to ensure that the annual soil intake volume is equal for both the Revised FS for Parcel D and RESRAD cases when exposure time and frequency are factored in.

2.2 RESRAD-BUILD

RESRAD-BUILD (NRC, 2000) is a modeling code used to estimate the potential radiological risk to an individual who works or lives in a building with residual radioactive material. It was used to evaluate the risk associated with occupying Parcel D-impacted buildings. The focus of this modeling was to estimate the increased cancer risk associated with any residual radioactive material left in the buildings after the buildings have been surveyed and released. Residual radioactive material is defined as any radioactive material below the residual cleanup goals. RESRAD-BUILD is similar to RESRAD in that the user can construct the exposure scenario by adjusting the input parameters. Typical building exposure scenarios include long-term occupancy (residential and industrial) and short-term occupancy (recreational and construction). The estimated dose can be the total (individual) dose to a single receptor spending time at various locations or the total (collective) dose to a workforce decontaminating the building. For purposes of these analyses, RESRAD-BUILD was run in individual dose mode.

RESRAD-BUILD has several input parameters that are grouped into the categories of building, source, and receptor. Using RESRAD-BUILD, buildings can be modeled as one-, two- or three-room structures. For simplicity of modeling, all buildings were modeled as a single-room structure with a default interior height of 2.5 meters. A room area of 100 square meters (m^2) was selected to be representative of a typical survey unit size. The source for each building was modeled as an area source that covered the complete floor area of the building, based on the assumption that the residual radioactive material would be uniformly distributed over the floor surface. The source activity was from the ROCs at the remediation goals. Receptor inputs were taken as the default values and the receptor was located in the middle of the building. All other building parameters used the default input value.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[1]
18	RESRAD-BUILD	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Section 5.0, pages A.5-1 and A.5-2. Tetra Tech EC, Inc. April 11, 2008.

5.0 EXPOSURE ASSESSMENT

The Revised FS for Parcel D provides both total and incremental risk associated with chemical constituents. To combine the chemical risk and radiological risk, the same approach used in the Revised FS for Parcel D to calculate chemical risk must be taken, namely, calculating total risk from ROCs inclusive of background and calculating incremental risk from the ROCs present at levels that do not include background. Of the ROCs for Parcel D, only ^{226}Ra is naturally occurring. ^{137}Cs and ^{90}Sr may be present in trace quantities because of fallout resulting from nuclear weapons testing. For the purposes of the radiological modeling, the background concentration for the ROCs other than ^{226}Ra are assumed to be essentially zero (i.e., zero picocuries per gram [pCi/g]). The ^{226}Ra background concentration is assumed to be the measured background level of 0.5 pCi/g.

To estimate the total risk from radiologically-impacted buildings, the background concentration of the ROCs is assumed to be zero (i.e., zero disintegration per minute [dpm]/100 square centimeters [cm^2]). This is a reasonable assumption since none of the ROCs are found in building materials except for ^{226}Ra, which can be found in building material made of earthen materials (i.e., cement, ceramic tiles). However, as a conservative modeling measure, the background concentration of ^{226}Ra in building materials is also assumed to be zero.

The risks associated with impacted sites at Parcel D are presented in this section. Summary dose and risk reports for RESRAD and RESRAD-BUILD calculations are provided on CD as Attachment 1 to this appendix.

5.1 RESRAD-BUILD

To estimate the total risk from impacted buildings the background concentration of the ROCs is assumed to be zero (e.g., zero dpm/100 cm^2). This is a reasonable assumption since none of the ROCs are found in building materials expect for ^{226}Ra, which can be found in building material made of earthen materials (i.e., cement, ceramic tiles) resulting in a negligible risk associated with radioactive constituents in building materials. Therefore the total dose and risk is equivalent to the incremental dose and risk. To estimate the incremental dose and risk from impacted buildings the ROCs are assumed to be at the remediation goals listed in Table A.4-1. Cases were run to estimate the dose and risk. For buildings with the same ROCs, a single case was run and the results applied to all like buildings. Multiple runs were not necessary to identify the critical exposure scenario (i.e., the scenario that presents the greatest risk). The reason for this is that occupancy time is the primary driver for the calculated risk: as occupancy time increases, so does the associated risk. Therefore, the resident scenario is the critical scenario providing the greatest risk estimate. The RESRAD-Build results are presented in Table A.5-1.

The combined total and incremental risk (e.g., both chemical and radiological) was derived by reviewing the Revised FS for Parcel D and locating grid points in close proximity to the impacted building. The risk for the impacted buildings estimated from RESRAD-BUILD and the Revised FS for Parcel D are presented in Table A.5-2.

5.2 RESRAD

The computer code used to model the chemical risk has a different set of user input parameters than RESRAD. Section 2.1 and its subsections above give some indication of the differences. The differences cause considerable difficulty in doing a direct matching calculation. Due to the inherent differences between the input parameters used for the Parcel D chemical risk assessment and the RESRAD input parameters, the default RESRAD parameters were used when estimating risk associated with residual radioactivity at Parcel D radiologically-impacted land areas. The only exception was the size for the area of contamination. For land areas smaller than 1,000 m^2 the actual size of the land area was used.

A land area of 1,000 m^2 was used instead of the default land area of 10,000 m^2 to accurately reflect the maximum size of a survey unit. Revising the default land area was done to be consistent with planned area of survey units for outside areas of 1,000 m^2. Using the smaller area will reduce the total risk for the modeled area.

To estimate the total risk from radiologically-impacted soil sites the background concentrations of the ROCs other than ^{226}Ra were assumed to be essentially zero (e.g., zero pCi/g). The ^{226}Ra background concentration is assumed to be the measured background level of 0.5 pCi/g. The ROCs are assumed to be present at equivalent fractions of the respective remediation goals listed in Table A.4-1 such that the sum of the fractions does not exceed one (i.e., unity rule). Table A.5-3 presents the total dose and risk from impacted soil sites estimated using RESRAD.

To estimate the incremental risk from impacted soil sites, the ROCs are assumed to be present at equivalent fractions of the respective remediation goals listed in Table A.4-1 such that the sum of the fractions does not exceed one (i.e., unity rule). The incremental dose and risk for the impacted soil sites estimated from RESRAD are presented in Table A.5-3.

The combined total and incremental risk (e.g., both chemical and radiological) was derived by reviewing the Revised FS for Parcel D and locating grid points in close proximity to the impacted soil sites. Chemical and radiological risks were added to yield combined risk. The risk for the impacted sites estimated from RESRAD and the Revised FS for Parcel D are presented in Table A.5-4.

In addition to site specific dose and risk assessment, several supporting studies were performed as part of this analysis. The supporting studies included a critical exposure scenario evaluation, critical pathway evaluation, cover depth study, and a contamination area study. The results of these studies are documented in the following subsections.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
19	Total radiological risks	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Table 3-3. Tetra Tech EC, Inc. April 11, 2008.

TABLE 3-3

RESRAD-BUILD RESULTS[a]

Parcel D Impacted Sites	Radiological Risk[b]	Dose[c]
Building 274	3.46×10^{-6}	3.57
Building 351	4.17×10^{-6}	28.5
Building 351A	4.73×10^{-6}	32.9
Building 366/351B	3.46×10^{-6}	3.57
Building 401	1.34×10^{-6}	0.644
Building 411	9.26×10^{-6}	11.0
Building 813	2.77×10^{-7}	0.69
Building 819	3.18×10^{-6}	2.89

Abbreviations and Acronyms:

a Total risk and dose is equivalent to incremental risk and dose
b Total excess lifetime carcinogen risk
c millirem per year

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
20	Assumptions and uncertainties	Section 2.5.1	Final Radiological Addendum for the Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California. Appendix A, Section 6.0, pages A.6-1 through A.6-3. Tetra Tech EC, Inc. April 11, 2008.

6.0 UNCERTAINTY ANALYSIS

Any comprehensive risk analysis must also consider the effects of uncertainty on input parameters. This analysis is no different; however, rather than perform explicit uncertainty analyses, which would have required countless additional RESRAD runs, an approach was taken that minimized the need for additional modeling computations. U.S. Nuclear Regulatory Commission Regulation NUREG-6697 (NRC, 2000) was used as the basis for the uncertainty analysis.

One of the primary purposes of NUREG-6697 was to study the effect of various parameter distributions on the final results of RESRAD analyses. As part of the NUREG study, multiple RESRAD runs were conducted for selected isotopes while varying a single parameter.

The majority of the RESRAD analysis relied on default parameters for the model. Since the RESRAD default parameters are developed to be representative of a wide range of scenarios there is considerable conservatism built into them. For those parameters which were changed from default values, the main purpose of the analysis contained in Appendix A was to provide risk values which could be added to those in the chemical FS analysis to obtain total risk. In some cases this added even more conservatism, such as by using high outdoor fractions, leading to higher direct exposure rates due to less shielding from structure walls. These changes were for a specific reason and the chemical and radiological risks are to be added. Actual field data will be used when calculating final dose and risk estimates.

The excluded pathways were selected primarily due to planned land use restrictions to be enforced after Parcel D has been turned over for redevelopment. It is assumed that adequate enforcement of the land use restrictions will be provided to eliminate the need to evaluate any potential use contrary to the restrictions (i.e. user activities resulting in what should be an inactive pathway becoming active).

In the case of the radon pathway, guidance presented in a White Paper titled *Using RESRAD in a CERCLA Radiological Risk Assessment* released by the Buffalo District Office of the U.S. Army Corp of Engineers in October 2002 indicates the radon model in RESRAD has a high degree of uncertainty. Furthermore it notes that existing radon limits and guidelines are based on concentration and not risk. As such the radon pathway is typically excluded from dose calculations and subsequent risk. Typically direct measurements are recommended as a better alternative to modeling.

Since the isotopes included in the NUREG-6697 study cover the majority of the ROCs at Hunters Point Shipyard, it was determined that the conclusions of the NUREG-6697 study could be used as the basis for the uncertainty analysis for the modeling done as part of the Revised FS for Parcel D Addendum. The uncertainty considerations for each ROC are discussed separately below.

Strontium-90

The most critical parameter affecting dose and subsequent risk from ^{90}Sr used in these analyses is the contaminated zone thickness. No other parameters used in this analysis had the potential to have any substantial impact on the results. As previously mentioned, the contaminated zone was dependent on the particular scenario being modeled. In all cases, however, the thickness was selected to be very conservative, and it is fully expected that the results presented in this analysis bound the actual case. It is therefore concluded that the conservatism built into this analysis eliminates the need to run additional uncertainty cases for ^{90}Sr.

Cesium-137

Dose and subsequent risk due to ^{137}Cs is primarily due to the external radiation pathway. The density and thickness of the cover material are the key parameters used in the RESRAD analysis that affect the risk associated with ^{137}Cs. Changes to the external gamma shielding factor also can affect the results to a lesser extent.

The RESRAD default cover material density was used for all analyses performed. The default was designed to be representative of the body of soil types. In some cases, an asphalt cover was modeled with the same default soil density. In reality, asphalt would have a greater density than the default soil value. The specific density is dependent upon the asphalt-laying process. By underestimating the density of asphalt, a certain measure of conservatism has been built into the results presented in this document. It is therefore reasonable to assume that any uncertainty associated with the cover material density is minimal and a full uncertainty analysis for a range of cover material densities is not necessary.

The selected cover thicknesses were selected based upon information in the Parcel D Revised FS (SulTech, 2007) and are consistent with average modern practices for site preparation. No additional runs are required to evaluate the uncertainty with this parameter.

The external gamma-shielding factor is a measure of how much shielding is offered by the building structures for a site receptor. This analysis used the RESRAD default value; however, since all receptor time was assumed inside the value selected for the gamma-shielding factor has no bearing on the final results. No explicit uncertainty analysis was performed for this parameter.

Radium-226

^{226}Ra is another nuclide with the majority of dose (for this analysis) resulting from the external radiation pathway. ^{226}Ra has a relatively long half-life of 1,600 years. Due to its longevity, the most important parameters affecting dose from ^{226}Ra in order from highest to lowest are thickness and density of the contaminated zone.

As noted for ^{90}Sr, the contaminated zone thickness has conservatism built in and thus does not require further uncertainty analysis. The density of the contaminated zone was modeled as the RESRAD default. All RESRAD default values are selected to provide conservative but reasonable estimates to a wider range of analyses. There is no added benefit to conducting more detailed uncertainty calculations for the ^{226}Ra dose based risk with varying contaminated zone densities.

Plutonium-239

^{239}Pu with a 24,000-year half-life has the contaminated zone thickness as the most influential parameter for ^{239}Pu dose in these analyses. The variability in results due to changes in this parameter is far greater than any other parameters. Since the previous discussions have established that the contaminated zone thickness has substantial conservatism included in it, there is no need to perform additional uncertainty calculations.

Thorium-232

Although ^{232}Th was not directly studied by NUREG/CR-6697, ^{230}Th was included in the study. For purposes of this analysis it is assumed that ^{230}Th and ^{232}Th would behave similarly. ^{232}Th has an extremely long half-life on the order of 14 billion years. Its primary contribution to dose is through the external pathway although the groundwater pathway becomes increasingly more important at longer times. It is unknown if the groundwater pathway surpasses direct exposure at some point since this analysis was only modeled out to 1,000 years. Thickness of the contaminated zone is the most sensitive parameter for thorium. As noted above, conservatism has been used in selecting the contaminated zone thickness; thus no additional uncertainty studies were necessary for ^{232}Th. Furthermore, the fact that the groundwater on Parcel D is not considered a viable source of drinking water further limits the impacts of uncertainty in the ^{232}Th concentration.

Item	Reference or Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record[a]
21	Ecological risk assessment	Section 2.5.2	Draft Final Parcel A Remedial Investigation Report, Hunters Point Shipyard, San Francisco, California. Section 6.2, Pages 6-13 through 6-17. PRC Environmental Management, Inc. and Harding Lawson Associates. September 22, 1995.

that Parcel A bedrock has never been used as a source of drinking water (EFA WEST 1995b). Fourth, the City of San Francisco's current groundwater policy excludes bedrock in Parcel A from potential future development based on the distribution of water in the bedrock and its characteristics (EFA WEST 1995b). Finally, correspondence dated April 13, 1995, from EPA states that a risk assessment for groundwater is unnecessary because "no CERCLA-regulated substances were identified in groundwater..." (EPA 1995c).

6.2 POTENTIAL HAZARDS TO ECOLOGICAL RECEPTORS

Potential risks to ecological receptors at Parcel A were qualitatively evaluated as part of the basewide Phase 1A ecological risk assessment (PRC 1994b). In addition to the basewide Ecological Risk Assessment, a screening-level QERA for Parcel A was conducted by EPA Region IX, Technical Support Section (EPA 1994a). The QERA was performed by EPA to confirm the initial findings presented in the Parcel A SI report (PRC/HLA 1993). The SI report concludes that residual contaminants left after the characterization of Parcel A are not expected to result in substantial chemical exposures and that no significant hazards are anticipated. The QERA concludes that because of limited areas of plant and animal species habitats and negligible contaminant levels associated with Parcel A, a minimal or very low risk to terrestrial ecological receptors is expected from Parcel A. The QERA does not assess the areas of Parcel A for which data are not available. The Phase 1A Ecological Risk Assessment and the draft QERA are discussed below. Conclusions drawn from the Phase 1A Ecological Risk Assessment and QERA are discussed at the end of this section.

6.2.1 Phase 1A Ecological Risk Assessment

The basewide Phase 1A Ecological Risk Assessment included the following steps: (1) site characterization, (2) characterization of plant and animal habitats and biota, (3) identification of Chemicals Of Potential Concern, (4) compilation of toxicological data on COPCs, (5) exposure pathway analysis, and (6) qualitative risk evaluation. A detailed description of the implementation of each of these tasks, including objectives, methodology, results, and analysis, is provided in the task summary reports (PRC 1994b). A brief summary of the Phase 1A Ecological Risk Assessment for Parcel A is provided in this section.

After the initial site characterization of Parcel A, habitats and biota were described. Habitats at Parcel A include ruderal (disturbed), nonnative grassland, and landscaped areas (see Figure 3-1, Task 3, task summary report, PRC 1994b). Lists of flora and fauna observed or expected to be present at Parcel A were compiled based on observations made during site walks and previous investigations by subcontractors (HLA 1991). The lists were also based on consultation with governmental and nonprofit biological organizations, including the California Department of Fish and Game, National Biological Survey, California Native Plant Society, Point Reyes Bird Observatory, Golden Gate Audubon Society, and California Academy of Sciences. Lists of threatened and endangered species, California special animals, and California special plants were compiled and are presented in the base realignment and closure cleanup plan for HPA (PRC 1995a).

Natural history data influencing the potential exposure to species observed or expected at Parcel A were compiled and presented in detailed tables provided in the task 3 summary report (PRC 1994b). Based on this information, a simplified terrestrial food web was developed, and potential exposure pathways were evaluated.

Because much of Parcel A is developed and covered by manmade structures such as housing and roads and because in open areas, yards, and the hillside, no significant exposure routes are expected for terrestrial species using Parcel A. For these reasons, no COPCs for ecological receptors were identified for Parcel A. Therefore, the risk to ecological receptors from Parcel A appears minimal.

6.2.2 Qualitative Ecological Risk Assessment

A summary of the QERA performed by EPA Region IX Technical Support Section is presented below (EPA 1994a).

6.2.2.1 Site History

The purpose of the site history phase of the QERA was to evaluate sites to determine the need for further characterization of ecological risk. The site history evaluation reviewed data presented in the Parcel A SI report for the following sites: PA-19, PA-41, PA-43, PA-50, PA-51, and SI-77. Except for PA-51 and SI-77, the sites are referred to as SI-19, SI-41, SI-43, and SI-50, respectively, in the RI report. The site history section of the draft QERA summarizes the physical characteristics of plant and animal habitat in Parcel A, contaminants detected, and other information.

The site history evaluation concludes that sites SI-19, SI-41 (Building 816 only), SI-43, and SI-50 should be considered further in the risk characterization section of the QERA. The following contaminants detected at these sites during confirmation sampling were considered to pose a potential ecological hazard: 2,4-D; 4,4'-DDD; MCPA; MCPP; Aroclor 1260; arsenic; lead; and magnesium. Because contamination was either below the pavement or at negligible levels, PA-51 and SI-77 were not considered in the risk characterization section of the QERA.

6.2.2.2 Habitat Assessment

The habitat assessment was conducted to qualitatively assess Parcel A's plant and animal life and to identify sensitive habitats. The habitat assessment was based on a site reconnaissance survey conducted on the evening of November 23, 1994, and the morning of November 24, 1994. The survey included walks on selected transects across the nondeveloped grassy slopes of Parcel A and behind Buildings 816 and 818. The survey supplemented previous site ecological investigations conducted by the Navy (EPA 1994a).

The QERA habitat assessment concluded the following:

- Notable vegetation includes a small strip of mature eucalyptus *(Eucalyptus sp.)*, intermittent strips of pines *(Pinus sp.)*, and a small area of cattail *(Typha sp.)*.

- The reconnaissance survey identified fifteen avian and four mammalian species. Notable activity consisted of foraging by the American kestrel *(Falco spaverius)*, which is a type of falcon. The red-shouldered hawk *(Buteo lineatus)* and red-tailed hawk *(Buteo jamaiscensis)* were observed perching within the eucalyptus canopy. Fox scat and tracks and burrows of Botta's pocket gopher *(Thomomys bottae)* were also observed.

- Floral diversity has been limited by a metal-rich serpentinite substratum. Faunal diversity is decreased by the limited vegetative resources, base facilities, and urban development. Parcel A is essentially ruderal and impacted by urban development, and its dominant vegetation (ornamental shrubs and nonnative grasses) provide marginal cover and food resources for animal species.

For purposes of the QERA analysis, two receptors were selected to model the potential risk from exposure to contaminants at Parcel A: the Botta's pocket gopher and the American kestrel. Botta's pocket gopher was selected to represent lower, trophic-level receptors that may be exposed to contaminants through several means, such as ingestion of contaminated food and soil and dermal exposure to contaminated soil in burrows. The American kestrel was selected to represent higher, trophic-level receptors that may be exposed to bioaccumulating contaminants such as DDT residues at Parcel A.

6.2.2.3 Risk Characterization

The risk characterization evaluated the potential for ecological risks from exposure to 2,4-D; 4,4'-DDD; MCPP; MCPA; Aroclor 1260; arsenic; lead; and magnesium at SI-19, SI-41 (Building 816 only), SI-43, and SI-50 by Botta's pocket gopher and the American kestrel. Botta's pocket gopher is a food resource for owls and American kestrels.

The risk characterization states that the expected primary exposure pathway for Botta's pocket gopher and the American kestrel is through incidental ingestion of contaminated food. Because of the relatively poor food sources at Parcel A, the potential for exposure is limited. The soil residual levels of contaminants were compared to no observed adverse effect levels (NOAEL) and lowest observed adverse effect levels (LOAEL) for the surrogate species cited in the QERA.

Based on the comparison to LOAELs, the primary COPC is 4,4'-DDD. A comparison of the LOAEL of 4,4'-DDD for eggshell thinning in American kestrels and barn owls suggests that the average residual concentration is less than the kestrel's LOAEL but that the maximum concentration approaches a level of concern. The QERA concludes that although the maximum contaminant level may pose risks to American kestrels, the exposure pathway is limited by the restricted foraging opportunities in Parcel A. Therefore, the ecological risk associated with 4,4'-DDD appears to be minimal at Parcel A.

6.2.3 Conclusions

The basewide Phase 1A Ecological Risk Assessment describes habitats and biota in Parcel A, and develops a simplified terrestrial food web, and evaluates potential exposure pathways. Because most of Parcel A is developed or covered with manmade structures no significant exposure routes are expected and the risk to ecological receptors appears minimal.

The QERA states that an analysis of risk is limited by the uncertainties discussed in the SI report. The QERA also concludes that because of the (1) limited habitat, (2) scarcity of potential receptors, and (3) generally reduced contaminant levels compared to NOAELs and LOAELs used in the QERA screening, risks to terrestrial ecological receptors are minimal at Parcel A. The QERA also recommends that any new information that indicates changes in the current characterization of contaminant conditions, ecological receptors, or exposure pathways should warrant reevaluation of the ecological risk at Parcel A. Based on the data gathered during the Phase 1A Ecological Risk Assessment and the draft QERA, the risk to ecological receptors from Parcel A appears minimal. The Navy does not anticipate further ecological investigations at Parcel A unless conditions affecting ecological risk change significantly.