Section 6. Conceptual Site Model

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

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

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

6.1. POTENTIAL SOURCES OF CONTAMINATION

The primary potential source of contamination at Parcel E-2 is solid waste in the Landfill Area. The solid waste consists of a contiguous layer of waste materials covering approximately 22 acres (Figure 6-1). Based on data from the 63 soil borings, monitoring wells and test pits extended within the Landfill Area, the solid waste is composed primarily of municipal-type waste and construction debris. The waste includes wood, paper, plastic, metal, glass, asphalt, concrete, and bricks, mixed with sand, clay, and gravel fill. Historic information indicates that industrial wastes were also disposed of in or around the Landfill Area; these included sandblast waste, radioluminescent devices, asbestos-containing debris, paint sludge, solvents, and waste oils (NEESA, 1984; NAVSEA, 2004). The surface of the Landfill Area is covered with either soil or an interim cap consisting of multiple geosynthetic and soil layers (Figure 6-1). The interim cap, installed to prevent oxygen intrusion and extinguish smoldering subsurface areas following a brush fire, covers approximately 14.5 acres and limits infiltration of precipitation into portions of the underlying waste.

Another primary potential source of contamination is the industrial waste disposed of in the East Adjacent Area and Panhandle Area. Two known hot spots within the adjacent areas are currently being removed under interim removal actions (Figure 6-1). Waste encountered in the Metal Slag Area includes metal slag and debris containing low-level radiological material and radioluminescent devices (BRAC PMO West, 2005b through 2005f). Waste encountered in the PCB Hot Spot includes sandblast waste, radioluminescent devices, and oily wastes (BRAC PMO West, 2005b through 2005f). Based on data from the 194 soil borings and test pits extended within the East Adjacent Area and Panhandle Area, fill material outside of these hot spots consists primarily of soil and rock fill, with lesser quantities of inert construction debris and isolated accumulations of putrescible construction debris (e.g., wood). With the exception of wood, the remaining types of construction debris are considered inert and are not expected to generate methane gas or leachate that would create potential risks to human health or the environment.

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

6.2. POTENTIALLY AFFECTED MEDIA AND MIGRATION PATHWAYS

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

6.2.1. Soil

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

6.2.1.1. Landfill Area Soil

At the Landfill Area, solid waste is intermixed with soil to a maximum depth of 14 feet below msl and varies in thickness from 10 to 25 feet thick. As shown in Figure 6-1, beneath the landfill, the waste overlies native soils consisting of Bay Mud and sand deposits. Within the landfill boundaries, subsurface soils that are commingled with waste materials have been potentially impacted by landfill contaminants.

As discussed in Subsection 4.5.3, soil characterization data within the Landfill Area was used to assess the approximate lateral and vertical extent (relative to the landfill waste volume) of constituent concentrations above the RIEC. Nearly all of the constituents detected above the RIEC in Landfill Area soil were of a limited extent relative to the overall waste volume. Several compounds, such as SVOCs, were detected throughout the Landfill Area at concentrations above the RIEC but not defined as “hot spots” based on the criteria for a hot spot as containing chemical concentrations 100 times greater than the corresponding RIEC. This threshold is discussed in Subsection 4.2.4. The potential PCB hot spots within the Landfill Area were localized relative to the overall waste volume, and were situated at relatively deep depths (between 11 and 17 feet bgs). The data, when considered in its entirety, demonstrate that lesser quantities of hazardous wastes are present in the landfill as compared with municipal-type waste and construction debris.

6.2.1.2. Adjacent Area Soil

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

Recent removal actions in the East Adjacent Area and the Panhandle Area at Parcel E-2 have removed PCB- and metals-contaminated soil through excavation, thus decreasing the spatial distribution of contaminants in soil in these adjacent areas within Parcel E-2. In particular, the excavation of the PCB Hot Spot within the East Adjacent Area removed near-surface PCB contamination. This near-surface PCB contamination is believed to be the source of elevated concentrations of PCBs detected in ambient air during the Phase II and III ambient air monitoring and during the construction of the interim landfill cap (see Subsection 3.7).

6.2.2. Subsurface Air / Landfill Gas

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

The subsurface air is partially comprised of landfill gas generated by the decomposition of organic waste in the Parcel E-2 Landfill. Potentially explosive concentrations of landfill gas (primarily methane) as well as NMOCs were detected north of the landfill boundary during previous investigations. The gas had migrated through the heterogeneous fill and waste material in the northern portion of the landfill and into the adjacent non-Navy property. No other landfill gas concentrations monitored in and around Parcel E-2 were detected at levels of concern. To address the landfill gas concerns on the northern boundary, a gas extraction and control system was installed to remove the landfill gas from beneath the non-Navy property and to control future gas migration north of the landfill boundary.

6.2.3. Outdoor Air

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

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

6.2.4. Groundwater

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

Groundwater contamination has been confirmed through sampling across Parcel E-2 in both the A-aquifer and uppermost B-aquifer. The lateral and vertical extent of chemicals in groundwater has been defined across most of Parcel E-2 through a series of investigations and the ongoing groundwater monitoring program. The groundwater chemical extent, however, is not completely defined along the Parcel E-2 shoreline. This uncertainty is highest at the PCB Hot Spot where concentrations of PCB, SVOCs, and TPH consistently exceeded RIECs prior to initiating the interim removal action. It is unknown how effective the excavation activities, which have been extended below the groundwater table, will be at reducing groundwater chemical concentrations in this area. Groundwater monitoring will resume in 2007, following completion of the excavation activities.

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

The major groundwater contaminant groups at the Landfill Area, East Adjacent Area, and Panhandle Area include VOCs, SVOCs, metals, TPH, pesticides, PCBs, and anions (such as cyanide). Groundwater sampling results indicate that the concentration and extent of contamination in the uppermost B-aquifer is less than observed in the A-aquifer due to the hydrogeologic and geologic characteristics (presence of Bay Mud) across most of Parcel E-2 (Figure 6-1). Overall, the number of detected chemicals and the magnitude of the concentrations detected in both aquifers have declined between 1990 and 2005.

6.2.4.1. Landfill Area Groundwater

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

6.2.4.2. Adjacent Area Groundwater

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

6.2.5. Surface Water

Surface water runoff (including runoff from freshwater wetlands located in the Panhandle Area) can be contaminated by leaching from contaminated soil or through surface erosion and subsequent suspension of contaminated soil in surface water. Primary potential migration pathways are migration/discharge of contaminated surface water and sediments into the intertidal zone (including tidal and emergent saltwater wetlands) and the Bay. Surface water discharge from the Parcel E-2 Landfill is managed in accordance with a SWDMP that was originally published in 2003 (TtEMI, 2003c). The Parcel E-2 stormwater program involves quarterly non-stormwater discharge visual observations, stormwater sampling and analysis, monthly stormwater discharge visual observations, and an annual comprehensive site compliance evaluation. Storm water monitoring locations and BMPs that are utilized at Parcel E-2 to control storm water discharges are shown on Figure 2-21. Results to date indicate no incidents of non-compliance at Parcel E-2 except in isolated locations where BMPs require modification to better control erosion and sediment transport.

6.2.6. Sediment

Sediments in Parcel E-2 are located in the Shoreline Area bordering the Bay as shown on Figure 6-1. For the purposes of this report, the extent of sediment is limited to this intertidal zone. The Shoreline Characterization Technical Memorandum (Appendix G) (SulTech, 2005) identified contaminated sediment along the length of the intertidal Shoreline Area. Primary potential migration pathways for the Shoreline Area are erosion by surface water runoff or tidal action. Details regarding the nature and extent of the sediment contamination in the Shoreline Area are described in Appendix G.

6.2.7. Wetlands

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

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

6.3. CONTAMINANT EXPOSURE POINTS, EXPOSURE ROUTES, AND RECEPTORS

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

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

6.3.1.1. Soil

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

6.3.1.2. Subsurface Air

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

The current operation of the gas control system is effectively preventing the off-site migration of gas on the northern boundary, and currently there are no buildings are constructed within Parcel E-2.

6.3.1.3. Groundwater

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

The RWQCB determined that the A-aquifer at HPS is not suitable or potentially suitable as a municipal or domestic water supply, and meets exemption criteria in SWRCB Resolution 88-63 and RWQCB

Resolution 89-39 (RWQCB, 2003). As a result, contaminants in A-aquifer groundwater are less likely to impact human receptors through direct ingestion, dermal contact, or inhalation. On-site workers could conceivably be exposed to A-aquifer groundwater if trenching activities occur to a depth where groundwater is encountered or if their work involves management of leachate. It is presumed, however, that these on-site workers will have proper training and are assumed to utilize proper protection for working with contaminated groundwater, which would greatly minimize exposure.

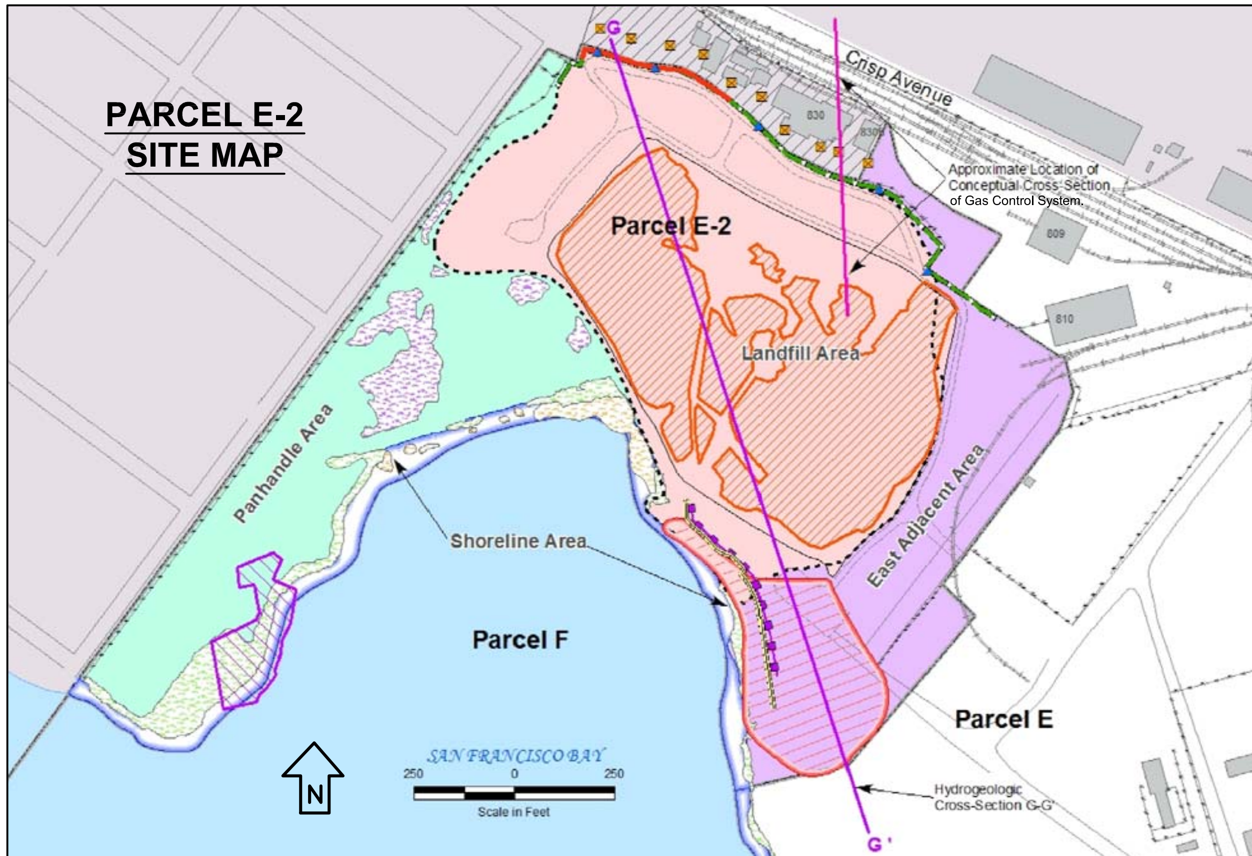
6.3.1.4. Surface Water/Sediment

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

6.3.1.5. Wetlands

Receptors in the wetlands area are the ecological receptors found in a wetland ecosystem. These receptors would be exposed to contaminants through ingestion and bioconcentration.

Figures



LEGEND

Ongoing Removal Actions

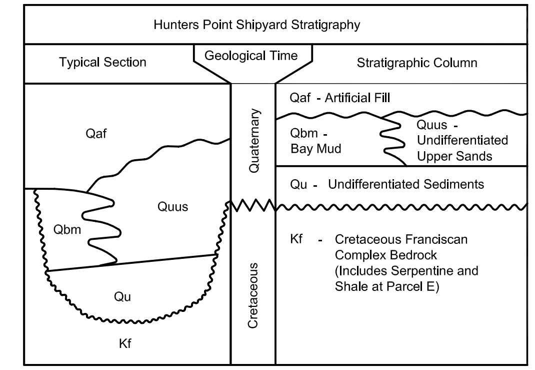
- Metal Slag TCRA*
- PCB Hotspot TCRA*
- Conceptual Cross Section
- Hydrogeologic Cross Section
- Burn Area
- Parcel Boundary
- Solid Waste Extent
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Shoreline Area
- Non-Navy Property
- UCSF Compound
- Building
- Fence Line
- Road
- Gravel Road
- Railroad
- Emergent Wetlands (7 Areas)
- Freshwater (5 Areas)
- Intertidal Saltmarsh (5 Areas)

Previous Removal Actions

- Interim Landfill Cap

Groundwater Extraction System
- Sheet-Pile Wall
- Extraction Trench

Interim Landfill Gas Control System
- Extraction Wells
- Passive Vents
- HDPE Barrier Wall
- Grouted Gundwall

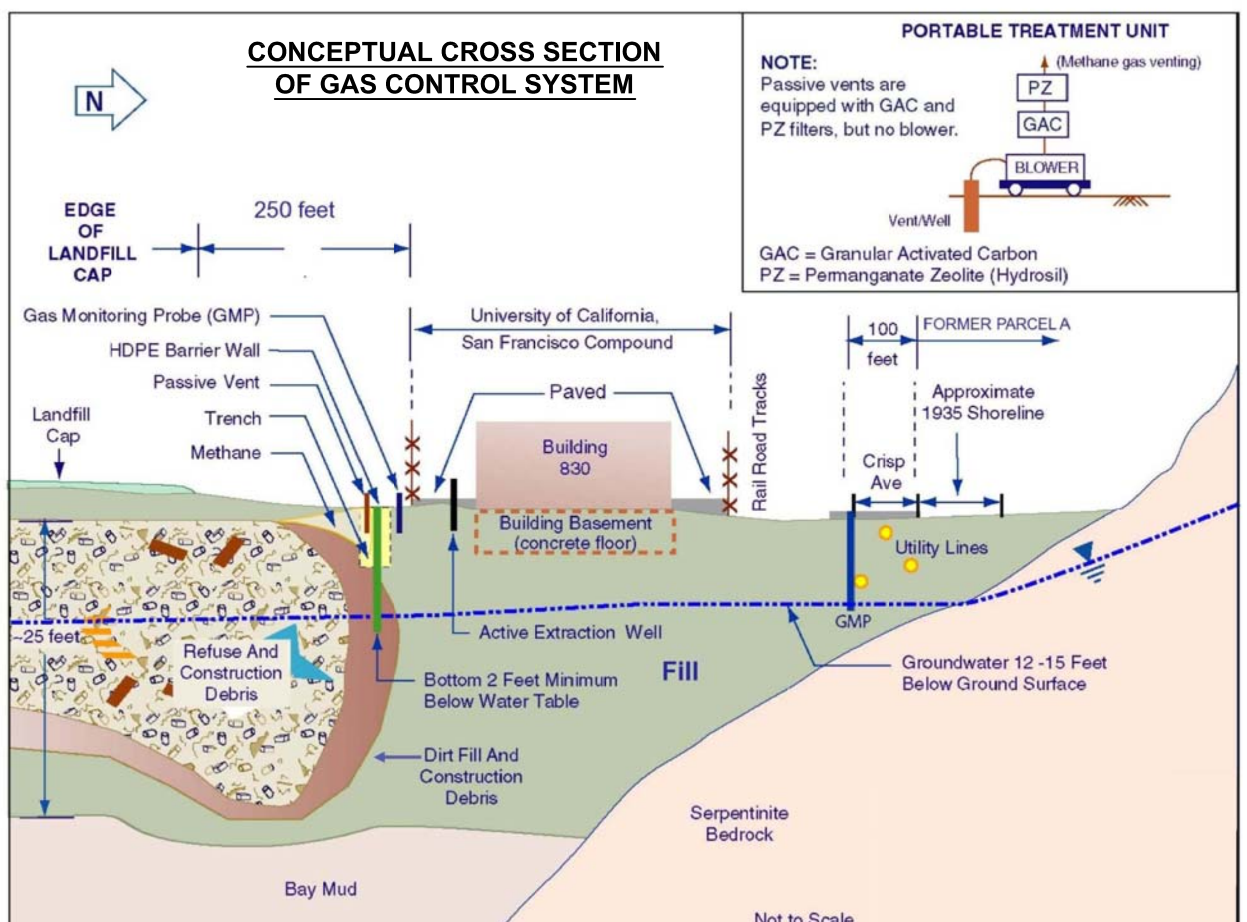


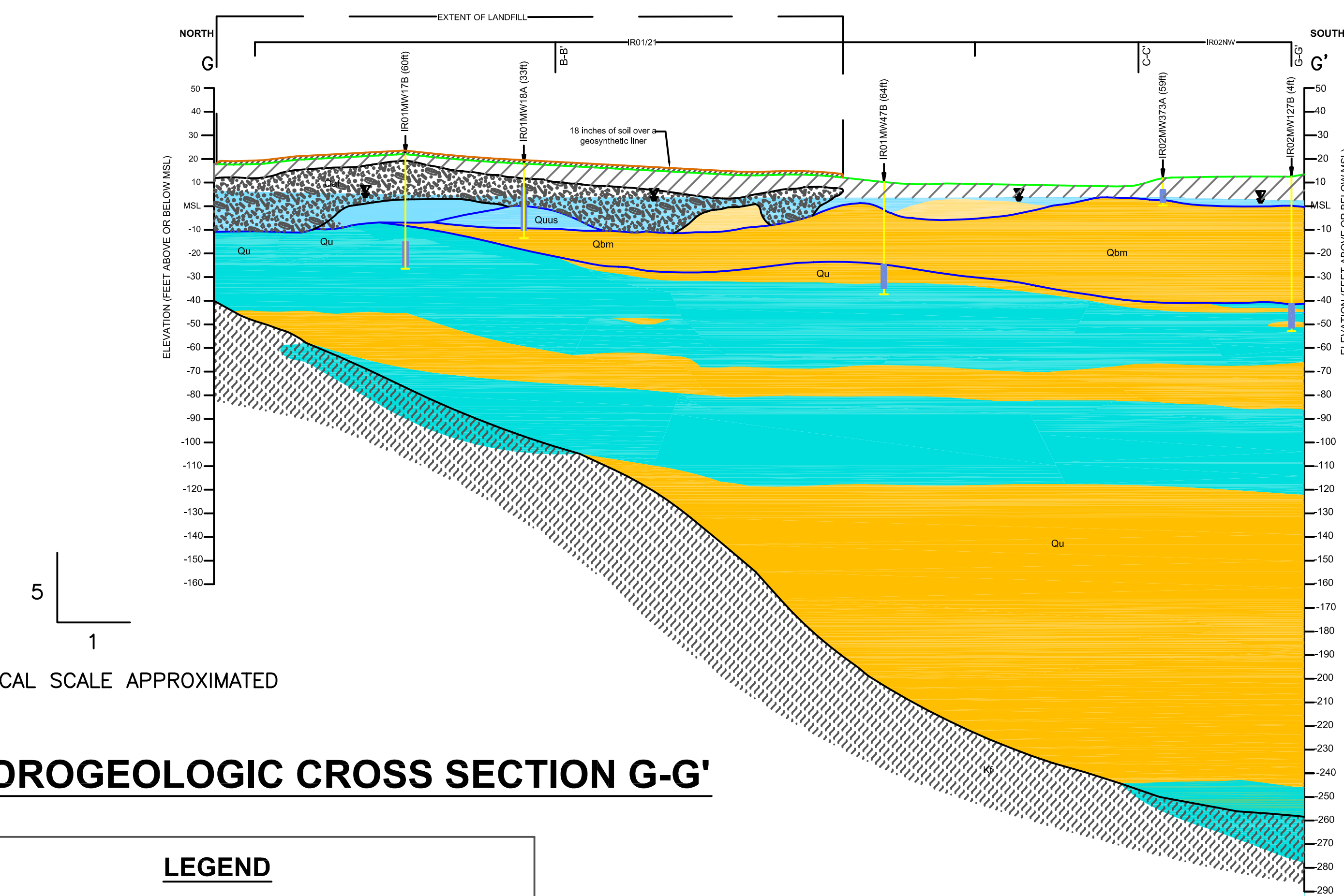
Notes:

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

Reference:

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





HYDROGEOLOGIC CROSS SECTION G-G'

LEGEND

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

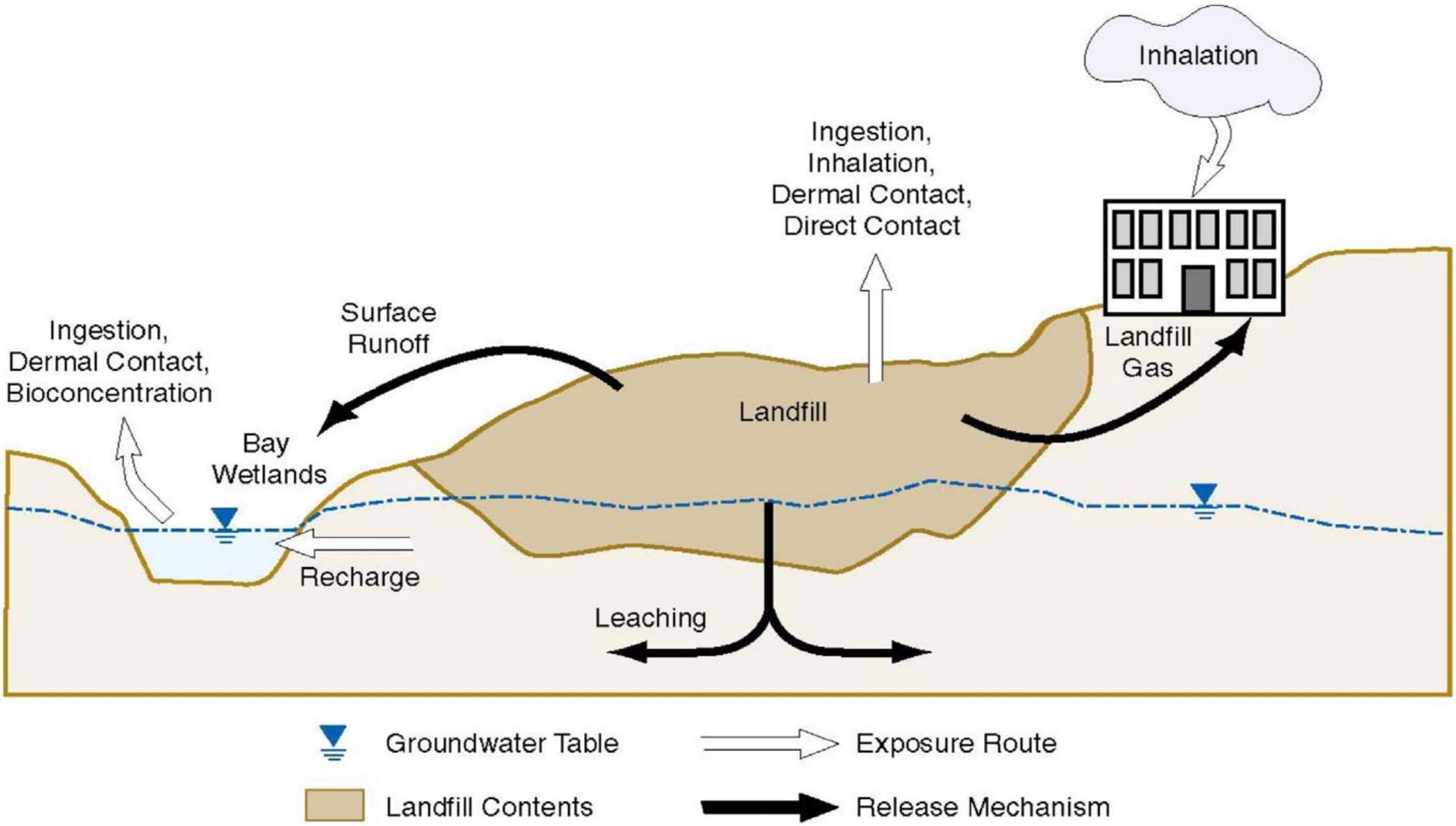
ERRG Engineering/Remediation Resources Group, Inc.

Hunters Point Shipyard, San Francisco, California

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

FIGURE 6-1
CONCEPTUAL SITE MODEL

Remedial Investigation/Feasibility Study for Parcel E-2



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

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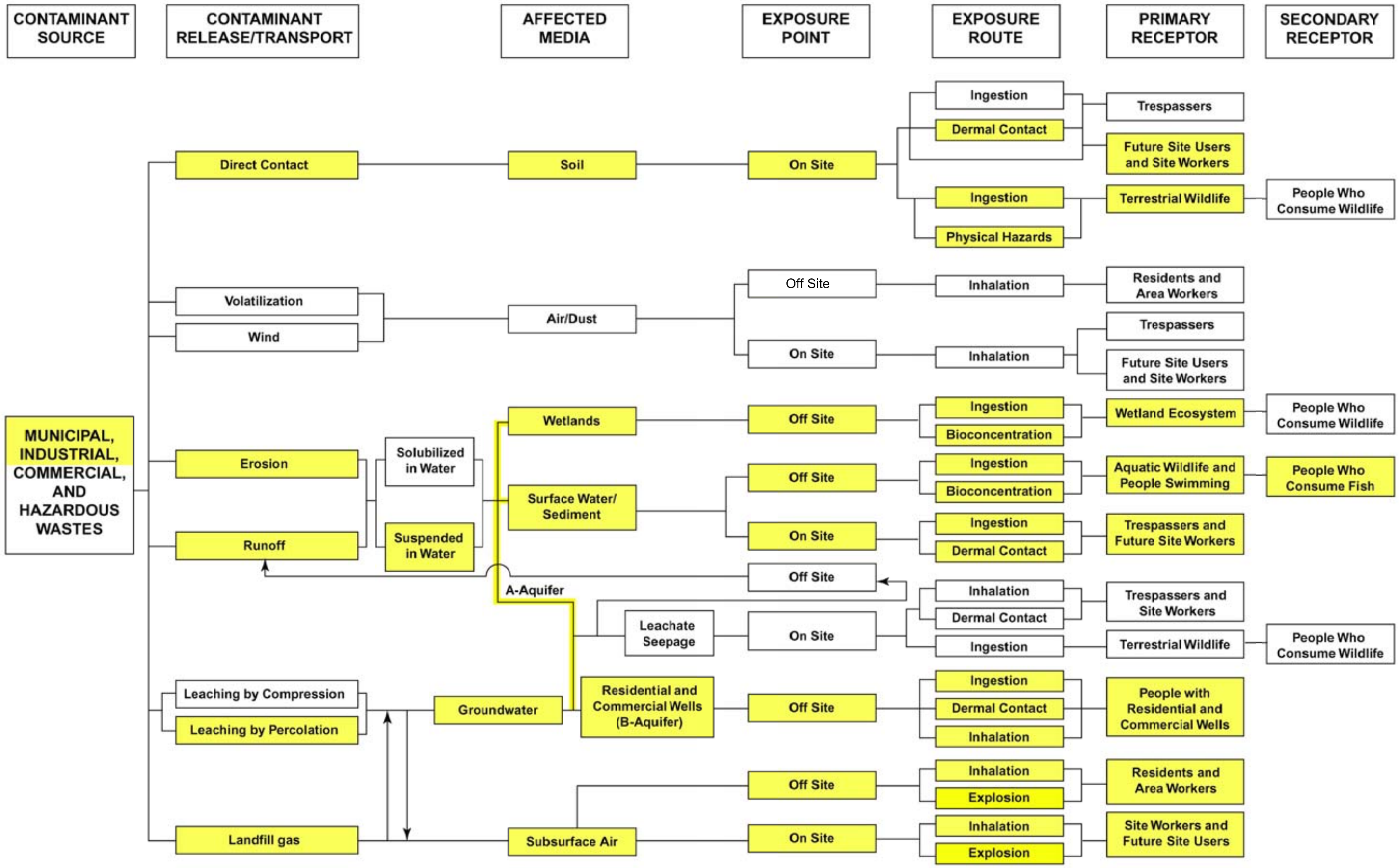
FIGURE 6-2
SCHEMATIC OF POTENTIAL MIGRATION PATHWAYS

Remedial Investigation/Feasibility Study for Parcel E-2



Primary exposure pathways are highlighted in yellow.

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

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FIGURE 6-3
Conceptual Site Model Flow Chart

Remedial Investigation/Feasibility Study for Parcel E-2