## LIST OF FIGURES

# EXECUTIVE SUMMARY

In 2003, the Golden Gate Audubon Society (GGAS) received funding from CALFED to: 1) determine the feasibility of the construction of a wetland to receive storm water runoff from the Hunters Point Shipyard sub-basin, and 2) provide a conceptual design for the wetland such that subsequent natural treatment of the storm water occurs within the wetland. In addition, as part of this project the GGAS has strived to provide the community with an alternative vision for the use of the area in Parcel E currently occupied by a landfill. The Project Team, including staff and students from San Jose State University, backed by staff from Brown and Caldwell, was hired to develop the conceptual design. The team made two key assumptions concerning the wetland:

- We assumed that the wetland would be located on the site of the current industrial landfill in Parcel E of the shipyard, and that the landfill would be removed.
- We assumed that there would be a water source capable of meeting the needs of the wetland alternative developed in this report.

The project goals outlined above align with those of The Hunters Point Shipyard Citizen's Advisory Committee (CAC), which convened in 1993 and was mandated to provide community oversight of the redevelopment process for the shipyard. The CAC goals include rejuvenation of the project area by returning the southeast waterfront to its natural ecology, and integrating open space with affordable housing, transportation, and industry. They proposed to use the toxic cleanup process to develop training, employment and business opportunities for community members. The CAC developed several guidelines which were integrated into a redevelopment plan (http://sfwater.org/detail.cfm):

- Create jobs for economic vitality
- Support existing businesses and an artist's community
- Create an appropriate mix of new businesses
- Balance development and environmental conservation
- Facilitate appropriate immediate access
- Integrate land use
- Acknowledge history

The development of new wetlands in Parcel E will comply with several of the guidelines set forth in the Hunters Point Shipyard CAC redevelopment plan, including provision of a balance in development and environmental conservation (by providing wildlife habitat), integration of land uses (by providing open space), and accessibility (by providing public access). The Executive Summary that follows provides a brief summary of the report.

**1. Site Description**

**Site Location.** Hunters Point shipyard is located in the southeastern part of San Francisco, California, between the Financial District of San Francisco and San Francisco International Airport. The shipyard area is approximately 936 acres, of which 493 acres are land and 443 acres are submerged under water in the San Francisco Bay.

**Site History.** Hunters Point shipyard was operated as a commercial dry dock from 1869 through 1939 (U.S. Navy, 2000; TetraTech, 2003a), and was in operation as a Navy facility from 1941 through 1974. In 1989, the site was placed on the National Priority List following the detection of extensive pollution. The Department of Defense listed the shipyard for closure in 1991 (U.S. Navy, 2000); in 1992, Hunters Point shipyard was divided into six parcels labeled A through F in order to expedite the investigation and cleanup.

**Parcel E Characteristics.** Parcel E consists of 167 acres located in the southwestern portion of Hunters Point Shipyard. This investigation is primarily concerned with the western portion of Parcel E that contains an industrial landfill. The landfill encompasses an area of approximately 20 acres and ranges in depth from 2 to 32 feet in depth. Approximately 15 acres of the landfill are under a landfill cap. The waste consists of a wide range of materials. The landfill has no bottom liner or leachate capture system, and bottom waste is in direct contact with groundwater.

**2. Review of Existing Data**

**Existing Wetlands.** According to the U.S. Navy and its consultants, the existing wetlands at Parcel E do not currently have recreational value since public access to this area is restricted. In addition, the wetlands are not considered to be unique or to have any cultural value since they are manmade and situated on artificial fill known to be contaminated with hazardous waste.

**Surface Water Sources.** The watershed area of the existing industrial landfill, excluding the landfill, is roughly 38 acres in total area and consists of approximately 24 acres of pervious area and 14 acres of impervious area (buildings and paved areas). In an effort to reduce the amount of volume of runoff available to potentially infiltrate and flow through the waste area of the industrial landfill located on Parcel E, an extensive storm water collection and diversion system has been installed.

**Potential Contaminants.** Surface water data indicate elevated concentrations of contaminants known to be present in the landfill, including arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc (Shirley, 2000). Ground water contamination as a result of the landfill has been confirmed based on the presence of various types of metals and chemicals in the ground water. Soil data collected by the U.S. Navy are consistent with the type of contamination known to exist in the landfill area.

**3. Wetland Site Conditions and Constraints**

**Wetland Water Needs.** At Hunters Point shipyard, annual precipitation ranges from approximately 10 to 30 inches and averages 20 inches. Annual evaporation is approximately 44 inches. Based on the water balance, storm water and direct precipitation are adequate to keep the wetland full from

November through March. Make-up water is needed from April through October when evaporation is high and inflow is low. Make-up water flow rates are around 2 acre-feet per month or 0.02 million gallons per day (mgd) in April and October, and around 9 acre-feet per month or 0.1 mgd from May through September. The total amount of recycled water required over the year is 46 acre-feet or 15 million gallons (Table ES-1). There is adequate recycled water supply within the shipyard to meet the modest needs of the wetland proposed in this report, presuming that a decentralized wastewater treatment plant is implemented.

**Table ES-1. Water Balance for Average Water Year for Hunters Point Wetland**

| | | | Inflow | | Outflow | | |
|---|---|---|---|---|---|---|---|
| Month | Precipitation (in/mo) | Evaporation (in/mo) | Direct Precipitation (acre-feet) | Runoff (acre-feet) | Evaporation (acre-feet) | Net Inflow (acre-feet) | Required Make-up Water (acre-feet) |
| January | 4.50 | 1.36 | 7.5 | 8.7 | -2.3 | 13.9 | 0.0 |
| February | 3.58 | 1.92 | 6.0 | 6.9 | -3.2 | 9.7 | 0.0 |
| March | 2.85 | 3.04 | 4.8 | 5.5 | -5.1 | 5.2 | 0.0 |
| April | 1.37 | 4.24 | 2.3 | 2.6 | -7.1 | -2.1 | 2.1 |
| May | 0.39 | 5.12 | 0.7 | 0.8 | -8.5 | -7.1 | 7.1 |
| June | 0.12 | 5.68 | 0.2 | 0.2 | -9.5 | -9.0 | 9.0 |
| July | 0.02 | 5.36 | 0.0 | 0.0 | -8.9 | -8.9 | 8.9 |
| August | 0.05 | 5.28 | 0.1 | 0.1 | -8.8 | -8.6 | 8.6 |
| September | 0.19 | 4.72 | 0.3 | 0.4 | -7.9 | -7.2 | 7.2 |
| October | 0.94 | 3.52 | 1.6 | 1.8 | -5.9 | -2.5 | 2.5 |
| November | 2.42 | 1.92 | 4.0 | 4.7 | -3.2 | 5.5 | 0.0 |
| December | 3.57 | 1.36 | 6.0 | 6.9 | -2.3 | 10.6 | 0.0 |
| Total | 20.00 | 43.52 | 33.3 | 38.6 | -72.5 | -0.6 | 45.5 |

**Landfill Issues.** Several issues exist related to the ability of the industrial landfill to contain waste and not function as a source of continued contamination to the San Francisco Bay and adjacent parcels at Hunters Point.

- Contaminant source. Surface runoff, ground water, and soils in Parcel E contain elevated concentrations of numerous contaminants. Of concern is the potential for infiltration through the landfill cover and ground water flows through the landfill waste to transport contaminants either within Parcel E, to adjacent parcels, or to San Francisco Bay.

- Extent of landfill. The location of contaminants deposited in the landfill remains somewhat unclear. It is known that the fill area extends outside of the area currently designated as industrial landfill, and that as a result, efforts to prevent infiltration, percolation, and contaminant transport may not be effective.

- Liquefaction potential. The potential for liquefaction in the vicinity of the landfill during earthquake activity is a serious concern. Lateral movement resulting in settlement could exert pressure on the landfill waste that could transfer contaminants outside existing boundaries, and potentially into areas being developed for public housing and open space.

- Landfill cap. The multilayer landfill cap does not cover the entire landfill area. The landfill cap was designed as an interim measure.

**4. Environmental Justice Issues.**

Remediation of the site should take into consideration the concerns and needs of the community living in and around the shipyard. Two issues are paramount:

- Residents of the adjacent areas around Hunters Point have expressed considerable concern about the health effects associated with the location of an industrial landfill in their community.
- At numerous former military installations in San Francisco, following base closure, the sites were remediated at great expense and redeveloped to include public access. Given the general lack of parks and recreational outlets in the Hunters Point area, remediation and restoration of the shipyard, and specifically the replacement of the Parcel E industrial landfill with a publicly accessible wetland, provides an exciting opportunity to afford local residence with equivalent access to natural open-space.

**5. Wetland Alternative Selection and Conceptual Design**

The three main objectives for wetland creation at Hunters Point were

- Provide opportunities for public education, access, and recreation.
- Create marsh habitat for desirable birds and aquatic biota.
- Improve the quality of storm water and wastewater effluent prior to discharge to San Francisco Bay.

Based on a review of project objectives, the permanent freshwater wetland system was determined to be the preferred alternative for Parcel E at Hunters Point because it is the only alternative that meets all the project objectives. Figure ES-1 shows the conceptual design developed by the project team for a permanent freshwater wetland in Parcel E of Hunters Point. The wetland includes a forebay/pond/wetland treatment train which provides a wide range of treatment capabilities and wildlife habitats. Total construction costs are estimated at $1 million and O&M cost are estimated at $40,000 per year. Final design/permitting fee should be around $100,000.

**6. Conclusions and Recommendations**

Based on this study we make the following twelve conclusions and recommendations which are discussed in more detail in Section 7:

- The development of new wetlands in Parcel E will comply with several of the guidelines set forth in the Hunters Point shipyard Citizen's Advisory Committee redevelopment plan.
- Remediation of the site should take into consideration the concerns and needs of the community living in and around the shipyard, with a focus on potential health effects.
- A properly constructed and operated wetland could result in an improvement in water quality in the San Francisco Bay by capturing and treating pollutants and sediment in storm water before they reach the Bay.
- Several issues exist related to the ability of the industrial landfill to contain waste and not function as a source of continued contamination to the area. Many of the issues and uncertainties would be ameliorated if the landfill was removed and replaced with a wetland.
- A permanent freshwater wetland system is the preferred alternative for Parcel E at Hunters Point. This alternative meets the multiple objectives of the project including year-round recreational opportunities, year-round habitat for wildlife, and storm water treatment.
- 46 acre-feet of make-up water are needed for the proposed wetland from April through October. The most suitable source of make-up water is recycled water from a satellite wastewater treatment plant proposed for the Hunters Point shipyard.
- A liner system should be installed between the wetland bottom and the existing soils on the site in order to isolate the wetland from contaminated ground water and soils.
- Any wetland design should include a forebay with easy drainage and access capabilities to capture, trap and remove contaminated sediment from storm water and keep it out of the wetland.
- To save money and ease construction, clean soils already on site should be used to fill in the excavated landfill after removal of the waste and to construct a liner to protect the wetland from underlying groundwater and soils.
- Wetlands can be designed and maintained to keep mosquito populations to a minimum by eliminating hydraulically static areas, controlling water level, disturbing water surface, minimizing anaerobic zones, and creating access for natural mosquito predators.
- Total construction costs are estimated at $1 million and annual O&M cost is estimated at $40,000. This estimated O&M cost is far below the current costs associated with management of the industrial landfill, which likely exceed $400,000 per year.

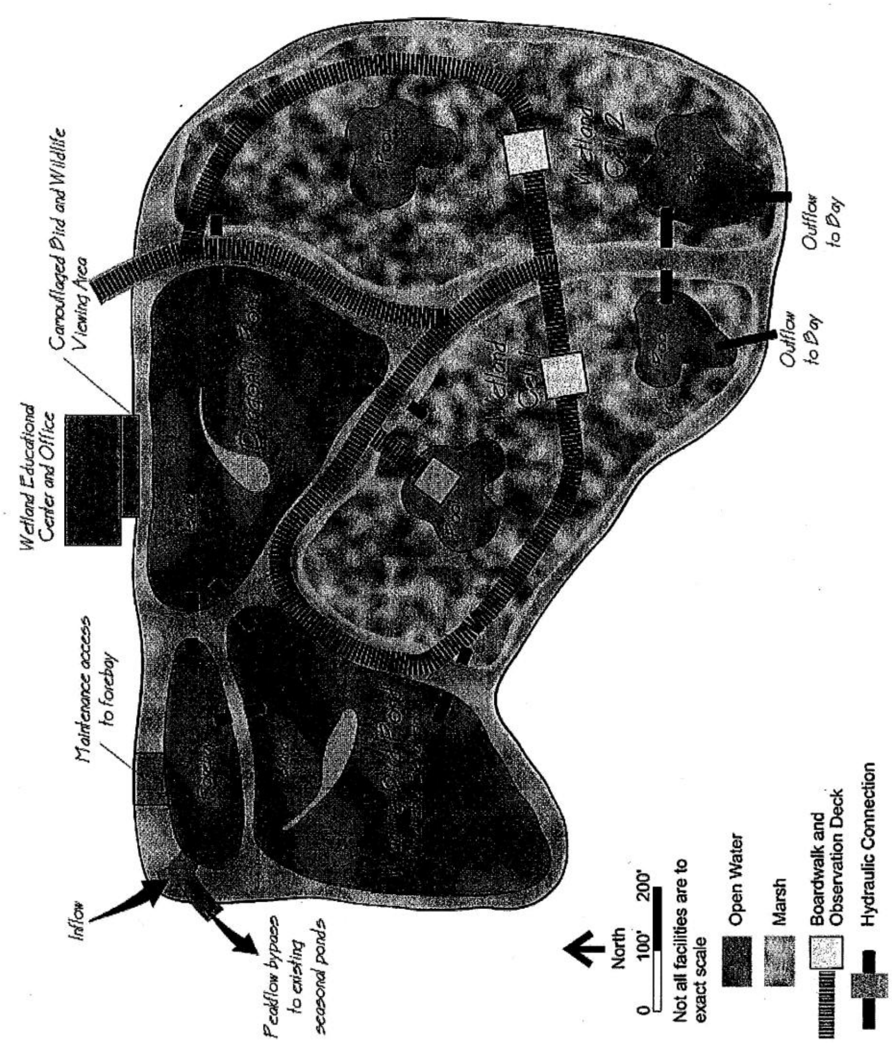


**Figure ES-1. Conceptual Design of Permanent Freshwater Wetland at Hunters Point**

# 1.0 INTRODUCTION

This section describes the project and the project goals. It also identifies project team members and their specific project responsibilities, as well as stakeholders to whom the report will be provided for review and comment. An overview of the format of the report is also provided.

## 1.1 Project Description and Goals

The Golden Gate Audubon Society (GGAS) received funding from CALFED to: 1) determine the feasibility of the construction of a wetland to receive storm water runoff from the Hunters Point shipyard sub-basin, and 2) provide a conceptual design for the wetland such that subsequent natural treatment of the storm water occurs within the wetland. The intent of the project is to provide a mechanism for segregation and treatment of storm water from municipal wastewater. In addition, this project provides the community with an alternative vision for the use of the area in Parcel E currently occupied by a landfill.

The project team was hired to perform a wetland feasibility study. Under the direction of the GGAS, the team made two key assumptions concerning the wetland. First, we assumed that the wetland would be located on the site of the current industrial landfill in Parcel E of the shipyard. We have assumed that the landfill will be removed, and its removal would provide an exciting opportunity to develop a wetland to provide multiple potential benefits including treatment of storm water, polishing of wastewater effluent, creation of wildlife habitat and development of recreational and educational opportunities for the surrounding community. Second, we assumed that there would be a water source capable of meeting the needs of the wetland alternative developed in this report.

The team performed an extensive review of pertinent data available on the Hunters Point shipyard site. Information and data were accessed through the Environmental Protection Agency's (EPA) database, the State of California Storage and Retrieval (STORET) system, and collected from documents on file with the United States Navy, the Department of Health Services (DHS), the United States Geological Survey (USGS), the Regional Water Quality Control Board (RWQCB), available consultants reports, the wastewater treatment plants, and other sources as identified during the review process. The data were evaluated and summarized in this report. Analysis of the data with respect to project feasibility, including watershed area, runoff discharges, water quality, soil quality, and potential for wetland use were included.

Using the collected data and information, the project team identified three conceptual wetland design alternatives which included provision for fresh and salt water wetland cells, and the potential for seasonal and/or permanent wetland cells. These alternatives were evaluated, taking into account the multiple objectives of the project, and a preferred alternative was selected. We then developed a conceptual design for the preferred alternative. The results of this project were presented to the GGAS and stakeholders at a community forum on June 24, 2004. Appendix A contains a summary of community comments and concerns.

### 1.2 Project Team and Stakeholders

This report was completed by a team of professionals and students under the supervision of the principal investigator, Dr. Rhea L. Williamson, and the San Jose State University Foundation (SJSUF). Dr. Marc Beutel of Brown and Caldwell was identified as a SJSUF subcontractor. Dr. Williamson was responsible for keeping the GGAS Contract Manager informed about the project status via bi-weekly project status meetings (via email, telephone or in-person) and written monthly progress reports. A listing of key project personnel and responsibilities is provided in Table 1-1. Stakeholders include the GGAS, the Hunters Point Community, the Hunters Point Shipyard Citizen's Advisory Committee, and others.

**Table 1-1. Project Personnel and Associated Responsibilities Specific to the GGAS Hunters Point Project**

| Duty | Responsible Team Member |
|---|---|
| Initiate and Administer the Project | Rhea Williamson |
| Review Existing Data | Rhea Williamson, Rashmi Kashyap, Divya Ramachandra |
| Identify Water Quality and Potential Contaminants and Sources | Rhea Williamson, Rashmi Kashyap, Wendy Jo Kroll |
| Develop Conceptual Design Scenarios | Rhea Williamson, Marc Beutel, Wendy Jo Kroll |
| Present Conceptual Design Scenarios to GGAS and the Community | Rhea Williamson and Marc Beutel, with students |
| Write and Submit Draft Final Report | Rhea Williamson and Marc Beutel, with students |
| Write and Submit Final Report | Rhea Williamson and Marc Beutel, with students |

### 1.3 Report Overview

Section 1 provides a brief description of the project, the project goals, and the project team and stakeholders. Section 2 provides a description of the site, including site location, site history, and characteristics of Parcel E. Section 3 presents existing data pertinent to wetland design including watershed characteristics, site hydrology, and water and soil quality. Section 4 reviews site characteristics and constraints relative to wetland implementation, including wetland objectives, alternative wetland types, water sources, groundwater issues, and regulatory constraints. In Section 5, we discuss wetland design features. Finally, in Section 6 we perform a wetland alternatives analysis and select a preferred wetland system. We then present a conceptual design for the preferred alternative. Section 7 presents a brief summary of conclusions and recommendations, and Section 8 includes references. The following Appendix section contains several appendices, including a summary of project meetings (Appendix B), documents reviewed (Appendix C), and persons contacted during the course of this project (Appendix D).

## 2.0 SITE DESCRIPTION

In this section, we discuss the location and history of the Hunters Point shipyard. The report focuses on Parcel E, the parcel where the proposed wetland would be sited. A description of existing wetland resources in Parcel E is also provided.

### 2.1 Site Location

Hunters Point shipyard is located in the southeastern part of San Francisco, California, between the Financial District of San Francisco and San Francisco International Airport (Figure 2-1). The shipyard area is approximately 936 acres, of which 493 acres are land and 443 acres are submerged under water in the San Francisco Bay (http://www.dtsc.ca.gov/database/ Calsites/CALP001). To the southwest of Hunters Point are 3Com Park and Candlestick Point. The port of San Francisco and the Mission Bay Project are to the north of Hunters Point. The site is on a relatively flat peninsula with views of the San Francisco Bay from Hunters Point Hill (Tetra Tech, 2003a). Hunter's Point is adjacent to San Francisco Bay to the south, and is bordered by the University of California, San Francisco compound to the north.

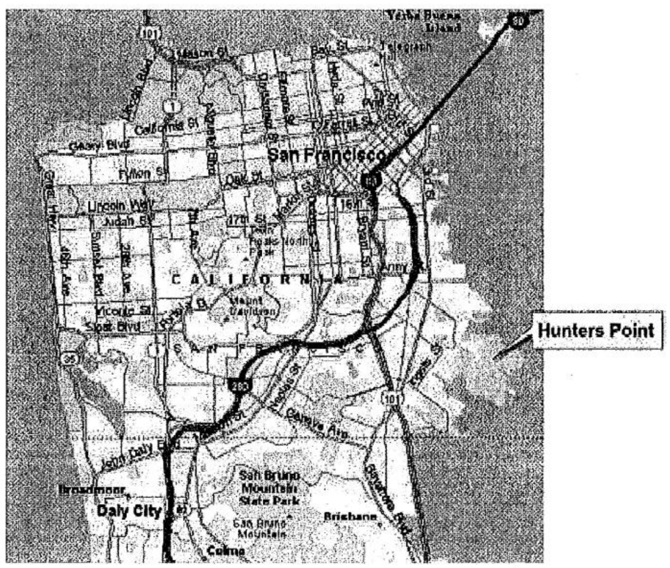


**Figure 2-1. Site Location Map**

2-1

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## 2.2 Site History

Hunters Point shipyard was operated as a commercial dry dock from 1869 through 1939 (U.S. Navy, 2000; TetraTech, 2003a). The shipyard was in operation as a Navy facility from 1941 through 1974. During this period, the Navy increased its ship building operations. In addition to ship building, the repair and maintenance of ships and submarines were also carried out at the site (Figure 2-2 and 2-3). The Naval Radiological Defense Laboratory (NRDL) was formed in 1946 to decontaminate and dispose of ships that returned from nuclear weapons test activities. The NRDL was active at Hunters Point from 1946 to 1969. During this period, several of the buildings at Hunters Point were used for radioactive laboratory operations, cyclotron operations, animal research studies, material storage, and/or processing (U.S. Navy, 2000)

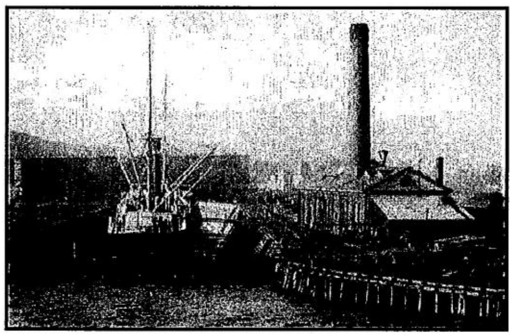

**Figure 2-2. Commercial Dry Dock in Use**
(http://www.dtsc.ca.gov/database/Calsites)

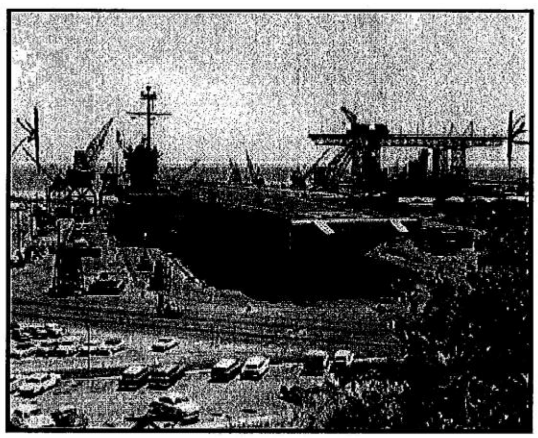

**Figure 2-3. Commercial Dry Dock in Use**
(http://www.dtsc.ca.gov/database/Calsites)

In 1976, a large section of Hunters Point shipyard was leased to Triple A Machine Shop (Triple A), a ship repair and maintenance facility (TetraTech, 2003a). Triple A continued its operations until 1986, when the company was charged by the District Attorney of San Francisco with improper disposal practices of hazardous wastes at nineteen locations throughout the Hunters Point shipyard, including the landfill in Parcel E (TetraTech, 2003b).

Hunters Point shipyard was placed on the National Priority List in 1989 following the findings of polychlorinated bi-phenyls, trichloroethylene, pesticides, petroleum hydrocarbons, metals and solvents at several site locations. The listing was made in part because of the proximity of the site to a drinking water source (http://www.dtsc.ca.gov/database/ Calsites/CALP001). The Department of Defense listed the shipyard for closure in 1991 (U.S. Navy, 2000). To better coordinate the environmental investigation and cleanup, the U.S. Environmental Protection Agency signed a Federal Facilities Agreement in January of 1992 with the U.S. Navy and the State of California. As a part of this agreement, Hunters Point shipyard was divided into six parcels labeled A through F, as shown on Figure 2-4, to expedite the investigation and cleanup.

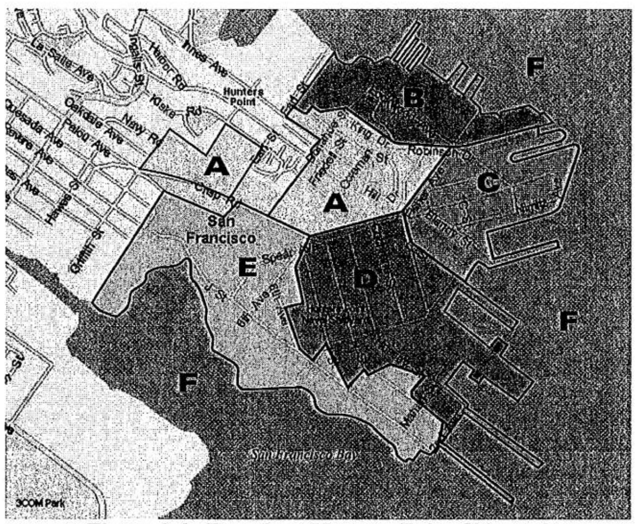


**Figure 2-4. Parcels at Hunters Point Shipyard**

In 1997, the San Francisco Board of Supervisors adopted the Hunters Point Naval Shipyard Redevelopment Plan after extensive multi-year community planning activities (http://sfwater.org/detail.cfm). The City Planning and Redevelopment Agency approved a companion document to the Redevelopment Plan called the Design for Development. These two documents identify the project goals and objectives, land use designations, development standards, community services and benefits, affordable housing and business relocation requirements, development approval process, and redevelopment financing opportunities for the shipyard. The aim was to rejuvenate the project area to return the southeast waterfront to its natural ecology, and to integrate open space with affordable housing, transportation, and industry. The plan proposed to use the toxic cleanup process to develop training, employment and business opportunities for community members.

A group of community residents and business owners, selected by the mayor of San Francisco, formed a committee known as The Hunters Point Shipyard Citizen's Advisory Committee (CAC). The CAC, which convened in 1993, was mandated to provide community oversight of the redevelopment process. The CAC developed several guidelines which were integrated into the redevelopment plan (http://sfwater.org/detail.cfm):

- Create jobs for economic vitality
- Support existing businesses and an artist's community
- Create an appropriate mix of new businesses
- Balance development and environmental conservation
- Facilitate appropriate immediate access
- Integrate land use
- Acknowledge history

The CAC holds monthly public meetings at the Southeast Community Facility in the Bay View District. In addition, a community-based website has been developed that provides an update of community actions and site information (www.communitywindowontheshipyard.org).

## 2.3 Parcel E Site Characteristics

Parcel E consists of 167 acres located in the southwestern portion of Hunters Point shipyard. Parcel E is bordered to the south by approximately 8,142 linear feet of baylands, and to the north by the University of California, San Francisco compound (Tetra Tech, 2003a) (Figure 2-5). This investigation is primarily concerned with the portion of Parcel E referred to as Installation Restoration (IR) -01/21, located in the northwest corner of Parcel E. This is the location of the proposed wetlands. IR-01/21 encompasses approximately 35 acres and includes roughly 20 acres of industrial landfill. Approximately 15 acres of the 20 acre industrial landfill are under a landfill cap. IR-01/21 is unpaved, has no buildings and is the home to 1.3 acres of seasonal freshwater wetlands (TetraTech, 2003a). The subsections below discuss the landfill and existing wetland resources in more detail.

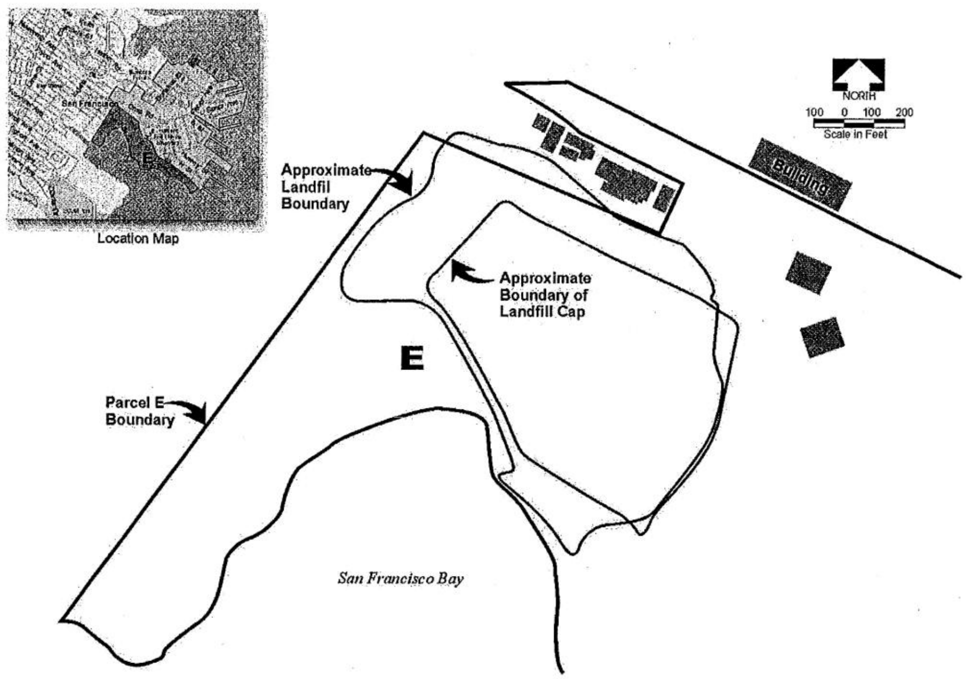


**Figure 2-5. Location of Landfill in Parcel E**

**Landfill Characteristics.** The Parcel E Landfill Background Booklet (www.communitywindowontheshipyard.org) provides an excellent overview of the history and current condition of the landfill. Since the late 1950s, the southern corner of Hunters Point shipyard has been used as a waste dump for byproducts of the industrial operations at the shipyard. Today, the landfill encompasses an area of approximately 20 acres and ranges vertically from 2 to 32 feet in depth. The landfill contains an estimated one-million cubic yards of waste. The waste consist of a wide range of materials including domestic refuse, sand-blast waste, construction waste (sawdust, wood, concrete, brick, asphalt), low-level radioactive debris, paint sludges, solvents and waste oils. Since the landfill was started before environmental regulations were developed for landfills, it has no bottom liner or leachate capture system, and bottom waste is in direct contact with groundwater. Soils, groundwater, and gasses within and emanating from the landfill are contaminated with a wide range of pollutants. Four major management activities have been implemented over the past decade at landfill.

- **Sand-Blast Waste Removal.** An estimated 4,000 cubic yards of sand-blast waste which was piled on the top of the landfill and caused a dust nuisance was removed from the site.

- **Sheet Pile Wall.** A 600-foot-long sheet pile wall was installed in the ground between the Bay and the landfill to intercept and pump out PCB contaminated groundwater from the site. The system cost $1,000,000 to build and $250,000 each year to operate. However, the system is ineffective since the groundwater being removed is not significantly contaminated by PCBs. Regardless, the system must remain in operation for regulatory reasons and to prevent water from building up behind the wall (Brownell, Personal Communications).

- **Landfill Cap.** A soil cap, approximately 15 acres in area, was put on the landfill to smother a fire within the landfill. The cap cost an estimated $10,000,000 to construct. It consists of a few feet of well-compacted soil covered by a specially designed fabric/clay liner that inhibits the flow of water down into the landfill. The liner is covered with a few feet of clean soil that supports vegetation. On-going maintenance includes watering and mowing of the plant cover.

- **Gas Collection System.** An extensive landfill gas collection system was installed along the northeast boundary of the landfill to collect and treat gasses escaping the landfill. Prior to the landfill cap, the gases seeped upwards and out the top of the landfill, but the cap forced the gas out the sides of the landfill. The system includes a 1,500-foot-long barrier wall in the ground, passive vents that filter then discharge the gas 15 feet above the ground, and extraction wells where gas can be vacuumed out of the landfill at high rates. Construction costs and operating costs of the system are unknown, but they are likely substantial.

**Existing Wetland Resources.** The majority of Parcel E was developed from extensive cut and fill operations performed by the U.S. Navy from 1940 to 1945 (US Navy, 2000). One result of this practice was the development of a heterogeneous construction-type fill material that has few, if any, inherent soil properties or characteristics. Due to the differential settlement of this heterogeneous fill and the construction of an earthen breakwater levee built along the shoreline with San Francisco Bay, numerous ponds and channels that seasonally retain water and do not readily drain were created. A culvert was constructed through the levee to allow drainage of water that accumulated during storm events in the low areas of IR-01/21. The culvert also functioned to ensure the stability of the levee. The elevation of the culvert controls the level of water accumulated behind the levee. The tide gate was originally meant to prevent salt water input during high tide however the culvert is open to tidal influx as a result of rust damage.

As a result of the low areas and drainage ditches that traverse Installation Restoration (IR) -01/21, approximately one acre of seasonal freshwater wetlands have developed, which are bordered by the Parcel E landfill to the northeast, the Bay view/Hunters Point district of San Francisco to the west and northwest, and a levee to the south (Tetra Tech, 2003c). The main source of water to these seasonal freshwater wetlands is surface water runoff, although tidal influx also occurs through the rust damaged tidal gate installed in the culvert. Due in part to tidal influx, the wetlands are vegetated with both freshwater and salt tolerant plant species (Tetra Tech, 2003c).

In addition to the freshwater wetlands in IR-01/21, the shoreline is punctuated with five discontinuous salt marsh areas totaling three acres. These bayside wetlands are bounded by a discontinuous erosion control riprap wall and the South Basin, which is contiguous with the San Francisco Bay (Tetra Tech, 2003c). In total, Navy consultants identified 22 potential jurisdictional wetland areas: 9 intertidal salt marshes, 8 emergent wetlands, and 5 freshwater wetlands (Tetra Tech, 2003c). The existing wetlands at the Parcel E do not currently have recreational value since public access to this area is restricted. Furthermore, the wetlands are not considered by the U.S. Navy and its consultants to be unique or to have any cultural value since they are manmade and situated on artificial fill known to be contaminated with hazardous waste.

The most significant features of Parcel E wetlands are the presence of known contaminants, existing vegetative cover, and its location along the Pacific Flyway. Due to the moderate mudflats adjacent to emergent vegetation, the wetlands support a diverse population of migrating and wintering birds. Few bird species have been identified by Navy consultants that breed in the area, presumably because of the small size and discontinuous nature of the wetlands, and limited vegetation diversity. Only red-winged blackbirds have been identified by Tetra Tech to nest in the freshwater wetland (Tetra Tech, 2003c).

However, a 2003-2004 wildlife survey for Yosemite Slough identified over 160 bird species on land and water in habitat adjacent to Parcel E (Lacy, 2004). In addition, over 3,000 birds were individually counted during a single monitoring event. Table 2-1 lists potential bird species that could benefit from a constructed wetland at Hunters Point.

**Table 2-1. Bird Species Potentially Inhabiting Hunters Point Shipyard**
(U.S. Navy, 2000)

| Common Name | Scientific Name | Federal Status[1] | State Status[2] |
|---|---|---|---|
| Western snowy plover | *Charadrius alexandrinus nivosus* | T | CSC |
| Peregrine falcon | *Falco peregrinus anatum* | E | E |
| California black rail | *Laterallus jamaicensis* | SC | T |
| California brown pelican | *Pelecanus occidentalis californicus* | E | E |
| California clapper rail | *Rallus longirostrus obsoletus* | E | E |
| California least tern | *Sterna antillarum browni* | E | E |
| Swainson's hawk | *Buteo swainasoni* | -- | T |
| Clark's grebe | *Aechmophorus clarkii* | -- | CSC |
| western grebe | *Aechmophorus occidentalis* | -- | CSC |
| tri-colored blackbird | *Agelius tricolor* | SC | CSC |
| burrowing owls | *Athene cunicularia* | SC | CSC |
| Barrow's goldeneye | *Bucephala islandica* | -- | CSC |
| common loon | *Gavia immer* | -- | CSC |
| sharp-shinned hawk | *Accipiter striatus* | -- | CSC |
| loggerhead shrike | *Lanius ludovicianus* | -- | CSC |
| California gull | *Larus californicus* | -- | CSC |
| Alameda song sparrow | *Melospiza melodia pusillula* | SC | CSC |
| long-billed curlew | *Numenius americanus* | -- | CSC |
| double-crested cormorant | *Phalacrocorax auritus* | -- | CSC |

[1]T = Threatened; E = Endangered; SC = Species of Concern.

[2]CSC = California Species of Special Concern; E = Endangered; T = Threatened.

## 3.0 REVIEW OF EXISTING DATA

Information and data on the Hunters Point shipyard site were collected from documents on file with the United States Navy, DHS, USGS, RWQCB, available consultant reports, the wastewater treatment plants and other sources as identified during the review process. This section presents data pertaining to watershed characteristics, and water and soil quality in Parcel E. Documents collected for review are described in Appendix C. Agencies and individuals contacted for information are listed in Appendix D.

### 3.1 Watershed Characteristics

**Hunters Point Naval Shipyard.** The shipyard lies in a lowland area bounded by hills to the northwest. The general topography of the shipyard area is coastal range and lowlands. Figure 3-1 shows a schematic of shipyard topography and surface runoff patterns, as well as the location of the landfill located in the western corner of the shipyard. From a peak elevation of 130 ft, the land slopes toward the San Francisco Bay, with most of the watershed located in coastal lowlands at an average elevation of 25 feet above mean sea level.

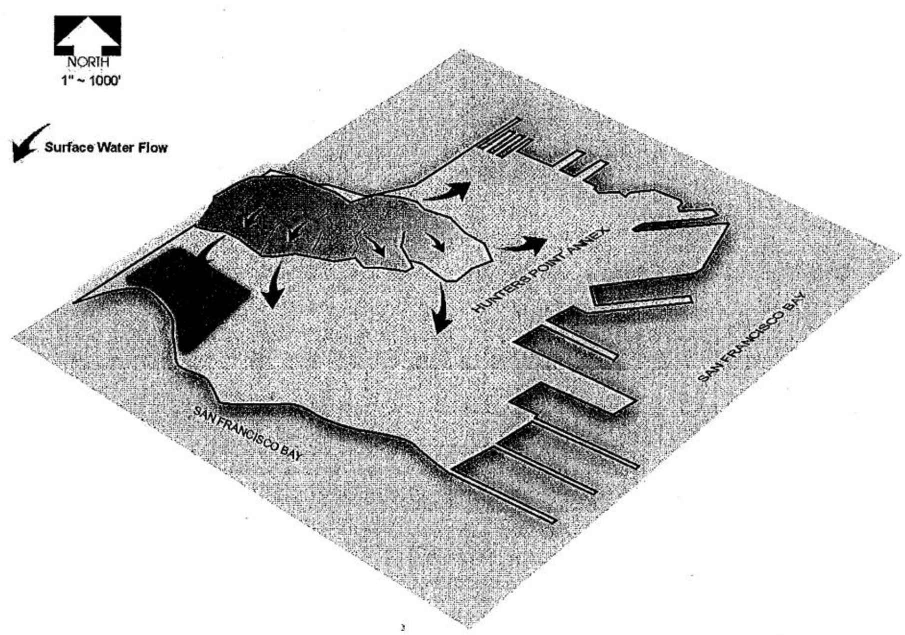


**Figure 3-1. Schematic of Surface Water Flow at Hunters Point Shipyard**

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3-1

**Parcel E.** Parcel E is located in the southern section of the shipyard and consists of 167 acres of shoreline and lowland coast (US Navy, 2000). The majority of the land use classifications within Parcel E are industrial, urban, and open space. The developed portion occupies approximately 65 percent of Parcel E and the remaining 35 percent is undeveloped (Tetra Tech, 2003c). The proposed wetland location is entirely within the coastal wetland region, on the southwest bayside boundary of Parcel E in a portion currently designated as industrial landfill. Figure 3-2 is a view to the north from the eastern border of the landfill on Parcel E.

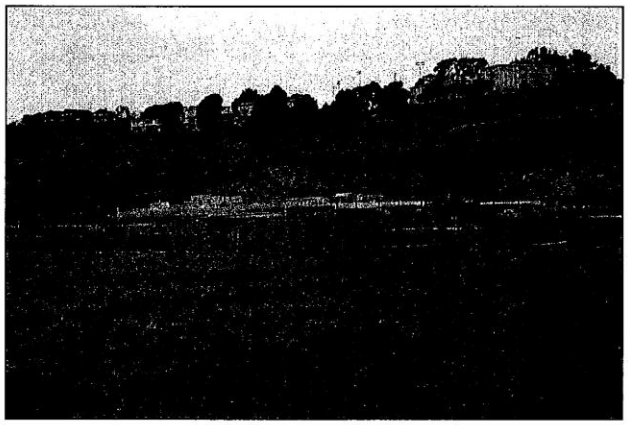


**Figure 3-2. View North from Eastern Border of the Landfill**

In an effort to reduce the amount of volume of runoff available to potentially infiltrate and flow through the waste area of the industrial landfill located on Parcel E, an extensive storm water collection and diversion system has been installed. Storm water runoff from the surrounding hills located to the northwest of Parcel E is collected in drainage channels on Parcel E and then indirectly discharged into San Francisco Bay through existing fresh water wetlands. Storm water from the southeastern portion of the site flows directly into San Francisco Bay (Tetra Tech, 2003a). In the northeastern portion of the site, storm water runoff drains into an existing storm water sewer system and discharges into San Francisco Bay through Outfall No. 33 (Tetra Tech, 2003a). Outfall No. 33 also receives runoff from the University of California at San Francisco (UCSF) parking lot. The only potential source of non-storm water on Parcel E is the landscape water used to maintain a vegetative cover on the landfill cap (Tetra Tech, 2003a).

**Landfill/Wetland.** Figure 3-3 shows the approximate boundary of the watershed for the existing landfill in Parcel E which is the location of the proposed wetland. The watershed, excluding the landfill, is roughly 38 acres in total area and consists of approximately 24 acres of pervious area and 14 acres of impervious area (buildings and paved areas). The watershed is bounded on to the northeast by the hill that protrudes into the shipyard and which slopes towards the landfill area, refer to Figure 3-1. Hydrologic calculations that estimate runoff from the watershed area to the proposed wetland are presented below in Section 4.

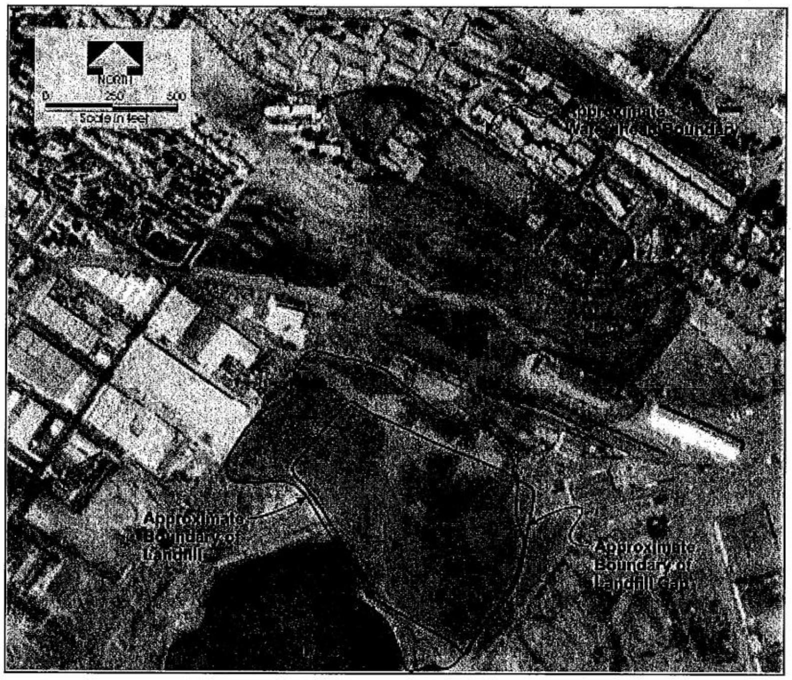



**Figure 3-3. Landfill/Wetland Watershed**

### 3.2 Site Hydrology

In this section, hydrological parameters at Hunters Point shipyard are discussed with a focus on the determination of the quantity of storm water runoff that would be available to support a permanent wetland in Parcel E. Parameters summarized include precipitation, wind speed, temperature, evaporation, and others. Weather conditions at San Francisco International Airport, located six miles to the south of Hunters Point, were used to approximate conditions at Hunters Point due to the lack of a local weather station.

**Precipitation.** Monthly average precipitation at San Francisco International Airport is shown in Figure 3-4. Annual average precipitation at Hunters Point is typically less than 20 inches. Precipitation is minimal during the summer months. Maximum rainfall typically occurs during the winter months of December and January at a rate of 2.5 to 4.5 inches per month respectively. Based on a fifty year precipitation database for the San Francisco International Airport collected between 1948 and 2003, the minimum and maximum annual rainfall was 9.8 and 39.8 inches (http://www.wrcc.dri.edu/summary/climsmsfo.html).

**Evaporation.** Also included in Figure 3-4 is evaporation for the San Francisco International Airport reported by the Western Regional Climate Center. Evaporation nearly equals or exceeds precipitation in all months excluding December, January and February. Evaporation rates are highest in summer months (4 to 6 inches per month) as a result of high air temperatures and wind speeds (see below). Annual evaporation totals 43.5 inches, and is over twice the average annual precipitation.

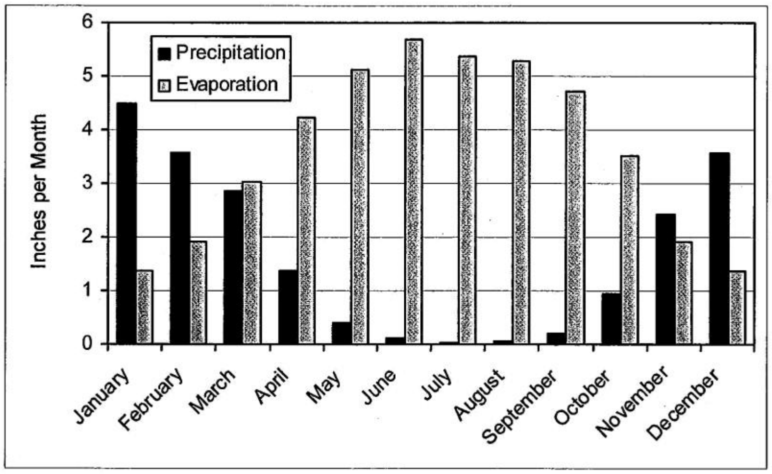



**Figure 3-4. Average Monthly Precipitation and Evaporation at San Francisco International Airport**
(http://www.wrcc.dri.edu/summary/climsmsfo.html)

**Temperature.** Temperature variations at San Francisco International Airport are summarized in Table 3-1. Monthly average temperatures at San Francisco International Airport range between highs of 56 to 74 °F and lows of 42 to 55 °F. Average temperatures peak in the summer and fall months from June through October.

**Table 3-1. Monthly Average Temperature at San Francisco International Airport**
(http://www.wrcc.dri.edu/htmlfiles/westwind.html)

| | Monthly Average Temperature (°F) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Max | 55.8 | 59.1 | 61.1 | 63.8 | 66.7 | 70.0 | 71.8 | 72.4 | 73.3 | 70.1 | 60.4 | 55.9 |
| Min | 41.8 | 44.5 | 45.8 | 47.2 | 49.6 | 52.3 | 53.8 | 54.8 | 54.6 | 51.8 | 45.6 | 42.3 |

**Wind Speed.** Monthly average wind speeds based on hourly observations from 1992 to 2002 are summarized in Table 3-2. Monthly average wind speeds range from 7 to 14 miles per hour (mph) and tend to peak in spring and summer months from April through August.

**Table 3-2. Monthly Average Wind Speeds at San Francisco International Airport**
(http://www.wrcc.dri.edu/summary/climsmsfo.html)

| Monthly average wind speed (mph) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 7.6 | 8.3 | 10.0 | 12.9 | 13.6 | 14.3 | 13.1 | 12.9 | 11.1 | 9.2 | 7.8 | 7.7 |

### 3.3 Potential Contaminants and Sources

Contaminants of concern that may enter the proposed wetland site via surface water, ground water, or runoff from the watershed are described in this section.

**Surface Water Quality.** An assessment of storm runoff water quality is essential to storm water wetland design. Such an assessment allows for the identification of potential contaminants of concern that may enter the proposed wetland site from the watershed. Surface water sampling results provided to Arc Ecology by the U.S. Navy indicate elevated concentrations of contaminants known to be present in the landfill, including arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc (Shirley, 2000).

Table 3-3 summarizes water quality in surface water collected on Parcel E reported by Shirley (2000). The table also includes groundwater quality objectives developed for Parcel B, as established by the Parcel B Record of Decision for the site. These objectives are water quality limits that are not to be exceeded in water discharged from Parcel B. The limits cannot be applied directly to Parcel E, but are provided for comparison purposes until Parcel E water quality objectives are developed. The surface water data indicate that runoff from Parcel E is high in contaminants and may result in deleterious impacts to water quality in San Francisco Bay. Storm water entering a wetland sited on Parcel E could potentially receive contaminated storm water, and this should be considered in the design and operation of any wetland at the site which will be used by wildlife. This data also points out that a properly constructed and operated wetland could result in an improvement in water quality in the Bay by capturing and treating pollutants in stormwater before they reach the Bay.

**Table 3-3. Surface Water Quality in Runoff from Parcel E**
(Shirley, 2000)

| Contaminant | Sampling Event 1 (μg/l) | Sampling Event 2 (μg/l) | Groundwater Trigger Level (μg/l) |
|---|---|---|---|
| Arsenic | 155 | 210 | 36 |
| Cadmium | 10.5 | 19.5 | 9 |
| Chromium | 132 | 268 | 16 |
| Cobalt | 27.7 | 41.7 | 20 |
| Copper | 340 | 530 | 28 |
| Lead | 3,980 | 8,840 | 14 |
| Mercury | 1.6 | 2.3 | 0.6 |
| Nickel | 153 | 206 | 97 |
| Petroleum | 18 | 7.4 | 1.4 |

**Groundwater Quality.** Two aquifers, A-aquifer and B-aquifer, are present under Parcel E. The A-aquifer is shallow and lies above the B-aquifer (Tetra Tech, 2003d). Depth to groundwater is around 15 to 20 feet and groundwater flows in a northwesterly direction. According to the RWQCB, the groundwater in A-aquifer is not suitable for either municipal or domestic use because of the contamination caused by the landfill. Neither natural formations such as an aquitard, nor geotechnical measures (for example, liners) separate waste deposited in the landfill from the A-aquifer. The B-aquifer is located at some distance below the A-aquifer, and groundwater flows in the deeper aquifer to the southeast. Although B-aquifer is considered suitable for potential municipal and domestic use, well construction is prohibited in most parts of the shipyard. Aquifers A and B are interconnected in the northern portion of the landfill.

Ground water contamination as a result of the landfill has been confirmed based on the presence of various types of metals and chemicals in the ground water. Metals, including copper, nickel, and zinc, volatile organic compounds (VOCs), pesticides, and polychlorobiphenyls (PCBs), exceed the evaluation criteria in groundwater samples collected in 2001 from the landfill area. In combination with site history, the presence of these contaminants indicates that ground water contamination exists (Tetra Tech, 2003d). Ground water data collected from throughout Parcel E indicate that the contamination is present not only in the industrial landfill area, but also in other Installation Restoration areas. Although the industrial landfill is situated mostly within IR-01/21, groundwater contamination extends into adjacent Installation Restoration areas, including IR-02, IR-12, and IR-56.

**Soil Quality.** According to a Soil Conservation Service soil survey, most of Parcel E is included in a general soil mapping unit called 'Unit 134-Urban land-Orthents, reclaimed complex, 0 to 2 percent slopes' (Tetra Tech, 2003c). The soil unit consists of areas covered by asphalt and concrete and also includes undeveloped areas. Areas that were once part of the San Francisco Bay and tidal flats are included in the survey and designated as recently man-made land areas consisting of a mixture of soil material, gravel, broken concrete, Bay mud, and solid waste materials. Two wetland-type clay soils are found in this mapping unit for Parcel E: Reyes clay and Novato clay. Both are hydric soils due to frequently high groundwater elevations. The soils have variable textures because of the presence of asphalt, concrete, or buildings, gravel, broken cement and asphalt.

Soil data collected by the U.S. Navy are consistent with the type of contamination known to exist in the landfill area (http://www.atsdr.cdc.gov/HAC/PHA.html). Unexpected are high concentrations of lead, copper, and other heavy metals very near the surface of the landfill (Shirley, 2000). Levels of antimony, arsenic, copper, lead, and zinc were detected above the interim ambient levels that were developed by the Navy, and agreed upon by the regulatory agencies (Table 3-4). These interim ambient levels are used as field screening criteria to identify "hot spots" or high levels of chemical constituents. Soil data for IR-01/21 and the interim ambient levels are much higher than background concentrations of trace and major elements in California soils (Bradford *et al.*, 1996). Based on this data, there is potential for the transport of contaminated soil in runoff during storm events to San Francisco Bay.

**Table 3-4. Maximum Contaminant Concentrations in IR-01/21 Soil**
(Harding Lawson Associates, 1994)

| Contaminant | Maximum Concentration (ppm) | 95% Upper Confidence Limit of the Arithmetic Mean (ppm) | Interim Ambient Level (ppm) |
|---|---|---|---|
| Aroclor-1242 | 32,000 | 3,981.5 | NA |
| Antimony | 1,930 | 316 | 20 |
| Arsenic | 315 | 54.2 | 16 |
| Beryllium | 12 | 1.96 | 1.3 |
| Cadmium | 983 | 53.3 | 11 |
| Copper | 175,000 | 30,968 | 110 |
| Lead | 19,200 | 3,144 | 14 |
| Manganese | 5,150 | 1,352 | 2,980 |
| Molybdenum | 641 | 97.9 | 5.4 |
| Nickel | 8,440 | 1,716.5 | 3,400 |
| Vanadium | 24,900 | 3,065.9 | 110 |

# 4.0 WETLAND SITE CONDITIONS AND CONSTRAINTS

## 4.1 Introduction

The design and construction of a wetland at Hunters Point shipyard requires consideration of site conditions that may affect the creation of wetland habitat and the ability to attract wildlife or promote human recreational activities at the site. This section provides summary information regarding the following topics:

- Water Needs
- Water Availability
- Landfill Issues
  - Contaminant source
  - Landfill lateral and vertical Extent
  - Liquefaction potential
  - Interim landfill cap
- Environmental Justice Issues
- Regulatory Constraints

## 4.2 Water Needs

Table 4-1 summarizes precipitation and evaporation data for the area. Annual precipitation ranges from approximately 10 to 30 inches and averages 20 inches. Annual evaporation is approximately 44 inches. Since evaporation exceeds precipitation, any permanent wetland in the area will need an additional source of water other than direct precipitation. Minimal water needs of a wetland in the area can be estimated based on the difference between evaporation and precipitation and the surface area of the wetland.

**Table 4-1. Monthly Precipitation and Evaporation Rates Near Hunters Point Shipyard**

| Month | Average Precipitation (in/mo) | Dry Year Precipitation[1] (in/mo) | Wet Year Precipitation[2] (in/mo) | Evaporation[3] (in/mo) |
|---|---|---|---|---|
| January | 4.50 | 2.36 | 6.49 | 1.36 |
| February | 3.58 | 1.88 | 5.16 | 1.92 |
| March | 2.85 | 1.49 | 4.11 | 3.04 |
| April | 1.37 | 0.72 | 1.97 | 4.24 |
| May | 0.39 | 0.20 | 0.56 | 5.12 |
| June | 0.12 | 0.06 | 0.17 | 5.68 |
| July | 0.02 | 0.01 | 0.03 | 5.36 |
| August | 0.05 | 0.03 | 0.07 | 5.28 |
| September | 0.19 | 0.10 | 0.27 | 4.72 |
| October | 0.94 | 0.49 | 1.36 | 3.52 |
| November | 2.42 | 1.27 | 3.49 | 1.92 |
| December | 3.57 | 1.87 | 5.15 | 1.36 |
| Total | 20.00 | 10.48 | 28.83 | 43.52 |

Notes
All data based on precipitation for SFO from 1948-2003; www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?casfoa+sfo.
[1]Dry year values based on 10th percentile of annual precipitation data set. This total is spread over the year based on the relative monthly precipitation for the average year (e.g., January has 22.5% of annual precipitation; February has 19.25% of annual precipitation, etc.).
[2]Wet year values based on 90th percentile of annual precipitation data set. This total is spread over the year based on the relative monthly precipitation for the average year.
[3]Values based on 80 percent of pan evaporation data for SFO estimated from meteorological data using the Penman equation; www.wrcc.dri.edu/htmlfiles/westevap.final.html.

To estimate the amount of alternative water supply needed for the wetland, we developed a monthly water balance for the site. The water balance for an average year is presented in Table 4-2. The first two columns show precipitation and evaporation. The next two columns estimate water inputs to the wetland. Direct precipitation onto the wetland is estimated as the monthly precipitation times the area of wetland (20 acres). Stormwater runoff is estimated as the area of the watershed (38 acres) multiplied by monthly precipitation and an estimated runoff coefficient of 0.61 (Appendix E). The runoff coefficient is based on land use and landscape slopes in the watershed. A value of 0.61 means that 61 percent of the precipitation that falls on the watershed runs off as overland flow. The remaining 39 percent infiltrates into the ground. Outflow is estimated as monthly evaporation times the surface area of the wetland. Net inflow is a summation of the inflows and outflow. Required make-up water is the amount of water need to offset negative monthly flows when there is a potential water deficit for the wetland.

**Table 4-2. Water Balance for Average Water Year for Hunters Point Wetland**

| Month | Precipitation (in/mo) | Evaporation (in/mo) | Inflow Direct Precipitation (acre-feet) | Inflow Runoff (acre-feet) | Outflow Evaporation (acre-feet) | Net Inflow (acre-feet) | Required Make-up Water (acre-feet) |
|---|---|---|---|---|---|---|---|
| January | 4.50 | 1.36 | 7.5 | 8.7 | -2.3 | 13.9 | 0.0 |
| February | 3.58 | 1.92 | 6.0 | 6.9 | -3.2 | 9.7 | 0.0 |
| March | 2.85 | 3.04 | 4.8 | 5.5 | -5.1 | 5.2 | 0.0 |
| April | 1.37 | 4.24 | 2.3 | 2.6 | -7.1 | -2.1 | 2.1 |
| May | 0.39 | 5.12 | 0.7 | 0.8 | -8.5 | -7.1 | 7.1 |
| June | 0.12 | 5.68 | 0.2 | 0.2 | -9.5 | -9.0 | 9.0 |
| July | 0.02 | 5.36 | 0.0 | 0.0 | -8.9 | -8.9 | 8.9 |
| August | 0.05 | 5.28 | 0.1 | 0.1 | -8.8 | -8.6 | 8.6 |
| September | 0.19 | 4.72 | 0.3 | 0.4 | -7.9 | -7.2 | 7.2 |
| October | 0.94 | 3.52 | 1.6 | 1.8 | -5.9 | -2.5 | 2.5 |
| November | 2.42 | 1.92 | 4.0 | 4.7 | -3.2 | 5.5 | 0.0 |
| December | 3.57 | 1.36 | 6.0 | 6.9 | -2.3 | 10.6 | 0.0 |
| Total | 20.00 | 43.52 | 33.3 | 38.6 | -72.5 | -0.6 | 45.5 |

Based on the water balance presented above, storm water and direct precipitation are adequate to keep the wetland full from November through March. Make-up water is needed from April through October when evaporation is high and inflow is low. Make-up water flow rates are around 2 acre-feet per month or 0.02 million gallons per day (mgd) in April and October, and around 9 acre-feet per month or 0.1 mgd from May through September. The total amount of make-up water required over the year is 46 acre-feet or 15 million gallons. An acre-foot is the volume of water equivalent to covering one acre of surface area one foot deep. It is roughly the amount of water that a typical family uses in one year.

Table 4-3 summarizes make-up water needs for a dry, average and wet year. Details are provided in Appendix F. In all years, 40 to 50 acre-feet of make-up water is required in the summer and fall to make up for evaporation losses. The average rate of usage of make-up water is around 0.07 mgd, and peak summer delivery rate is around 0.1 mgd. It is important to note that the volumes and flow rates reported here are minimal water needs for a permanently flooded wetland. Higher volumes and flow rates could be discharged to the wetland if water was available, and if recycled water was used, a significant improvement in water quality, particularly in nutrient levels, could be achieved. Conversely, water needs could be decreased simply by making the wetland smaller in area, or by allowing the wetland to dry out during the summer and fall.

**Table 4-3. Estimated Make-Up Water Needs of 20 Acre Wetland at Hunters Point Shipyard**

| Year | Total water needs, April through October | | Average delivery rate, million gallons per day |
|---|---|---|---|
| | Acre-feet | Million gallons | |
| Dry | 51 | 17 | 0.08 |
| Average | 46 | 15 | 0.07 |
| Wet[1] | 41 | 13 | 0.07 |

[1]In wet year, water is only needed from May through October.

## 4.3 Water Availability

Alternative sources of make-up water for the wetlands include potable water or recycled water from local wastewater treatment plants and/or satellite plants. Potable water is not recommended due to the cost of purchasing the water. The most suitable source of make-up water is recycled water, treated effluent from a wastewater treatment plant. A recent draft report entitled the Hunters Point Shipyard Decentralized Wastewater Treatment Study (February 2004) recommends implementation of a decentralized wastewater treatment plant at the shipyard. The plant would treat wastewater produced at the shipyard and reuse the treated effluent for in-building dual plumbing demands, landscape irrigation, and environmental enhancement such as wetlands.

Estimated future wastewater flows produced within the shipyard range from 2 to 5 mgd. The draft study examined the cost and feasibility of treatment plants ranging in size from 0.5 to 4.0 mgd. Based on this study, there is adequate recycled water supply within the shipyard to meet the modest needs of the wetland proposed in this report, presuming that a decentralized wastewater treatment plant is implemented. The minimum size of such a plant would be on the order of 0.5 mgd. This compares with a wetland peak water demand of around 0.1 mgd between April and October. In addition, the recommended site of the decentralized wastewater treatment plant was in the light-industrial area of Parcel E or near an existing pump station facility in Parcel A. Both of these proposed areas are relatively close to the proposed wetland in Parcel E, thus delivering the water to the wetland would not be too complicated or expensive.

## 4.4 Landfill Issues

Several issues exist related to the ability of the industrial landfill to contain waste and not function as a source of continued contamination to the San Francisco Bay and adjacent parcels at Hunters Point. These issues, discussed below, include the lateral and vertical extent of the landfill, the potential for liquefaction, and the construction and/or extent of the landfill cap. Many of the issues and uncertainties would be ameliorated if the landfill was removed and replaced with a wetland.

**Contaminant Source.** Surface runoff, ground water, and soils in Parcel E contain elevated concentrations of numerous contaminants. Of concern is the potential for infiltration through the landfill cover and ground water flows through the landfill waste to transport contaminants either within

Parcel E, to adjacent parcels, or to San Francisco Bay. As discussed earlier, a slurry wall barrier and a ground water extraction system were constructed to limit the migration of ground water contaminated from the landfill into San Francisco Bay (Tetra Tech, 2003b). A drainage system along the northern perimeter of the landfill was constructed to intercept runoff from the watershed and divert it around the landfill. In addition, a landfill gas collection system was installed along the northern boarder of the landfill to intercept, treat and dilute landfill gasses into the atmosphere. In order to prevent the landfill from acting as a contaminant source, these engineered solutions must be maintained and monitored continuously. Operation of the ground water extraction system alone costs an estimated $250,000 per year to operate (communitywindowontheshipyard.org).

**Extent of Landfill.** The location of contaminants deposited in the landfill remains somewhat unclear. It is known that the fill area extends outside of the area currently designated as industrial landfill, and that as a result, efforts to prevent infiltration, percolation, and contaminant transport may not be effective. Results of a recent study to define the extent of the landfill are discussed below.

Between March and September of 2002, an investigation was conducted to determine the extent of waste fill at the Hunters Point industrial landfill (Tetra Tech, 2003b). Test pits were dug around the border of the landfill to estimate the lateral extent of the landfill. Along the northern perimeter of Parcel E landfill waste extends from under the landfill cap to a few feet from the fence that separates the UCSF compound from the landfill. Landfill waste was also found in borings along the eastern extent of the northern perimeter. Test pit data indicated that the eastern perimeter of the landfill is beneath the interim cap. Test pit data along the western perimeter of the landfill, which is adjacent to a warehouse/industrial area, also contained landfill waste. Data obtained along the northern border has reportedly been used to design a barrier wall to divert ground water around the landfill, and a vent system to contain the landfill gas within the footprint of the landfill.

The vertical extent of landfill waste was assessed by a series of test borings. Boring data collected along the perimeter of the landfill confirmed that the bottom of the waste was usually deeper than the bottom of the test pits excavated to determine the lateral extent of the landfill. Landfill waste was generally located between 20 feet above mean sea level and 14 feet below mean sea level. The thickness of the waste was found to vary from 10 to 25 feet. In most test borings drilled deeper than 15 feet below grade, the water table was encountered before the bottom of the waste. The only exception to this was at the northwest corner of the landfill, where the water table was located deeper than the bottom of the waste. The waste was deposited directly on top of Bay mud in the southern and eastern portions of the landfill, and on top of the sands of the B-aquifer in the northwestern portion of the landfill.

Figure 4-1 shows a cutaway side-view of the landfill presented by Tetra Tech in the Landfill Lateral Extent report (2003b). The figure shows a transect of the landfill running across the shorter width of the landfill from the northeast (on the right) to southwest (on the left). The waste is colored gray. Surrounding soils and clays are colored in browns, yellows, greens and blues. The landfill cap is colored in red. The surface of the ground water is shown in light blue and Bay water is colored purple. The waste generally lies in a region from -10 to +10 feet above mean sea level and ranges in thickness from 10 to 20 feet. Note that the ground water elevation is around 4 feet above mean sea level and waste below this elevation is in direct contact with ground water. Also note that the interim cap does not cover the edges of the landfill.

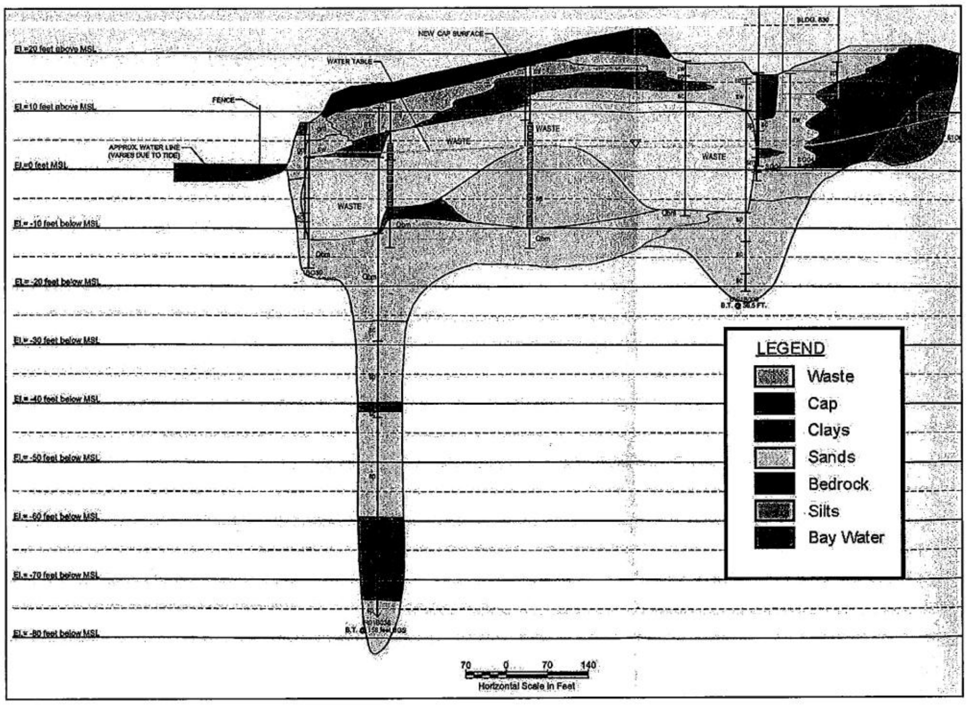



**Figure 4-1. Cutaway View of Landfill in Parcel E**
Source: Tetra Tech (2003b)

**Liquefaction Potential.** A field investigation was recently conducted to evaluate the potential for liquefaction in subsurface soil in areas surrounding Parcel E (Tetra Tech, 2003b). The study determined the type of soil layer, as well as its thickness, density, and ability to transmit lateral motion through the soil column above bed rock. Standard geotechnical test were performed on multiple soil samples. Results indicate that lateral soil movement of 1.5 to 5 ft could occur during an earthquake, with non-uniform soil liquefaction across Parcel E due to varying soil type and depth. In addition, settlement due to liquefaction on the order of 5 to 10 inches could be expected. This data suggests that the potential for liquefaction in the vicinity of the landfill during earthquake activity is a serious concern. Lateral movement resulting in settlement could exert pressure on the landfill waste that could transfer contaminants outside existing boundaries, and potentially into areas being developed for public housing and open space (Parcel A). In addition, wastes in the landfill could be redistributed causing chemical reactions resulting in contaminant releases in the form of gases, fires, or leachate.

**Landfill Cap.** In 2000, a multilayer landfill cap was installed to smother a fire within the landfill and to prevent percolation of the surface runoff through the landfill. The cap consists of a few feet of well-compacted soil covered by a specially designed fabric/clay liner covered with a few feet of clean soil that supports vegetation. The landfill cap is offset from the landfill to the north and does not cover the entire landfill area. The cap cost an estimated $10,000,000 to construct and ongoing maintenance is required to promote and control the growth of suitable plants on top of the cap.

### 4.5 Environmental Justice Issues

Residents of the adjacent areas around Hunters Point have expressed considerable concern about the health effects associated with the location of an industrial landfill in their community (http://www.atsdr.cdc.gov/HAC/PHA.html). Of great concern is the fact that according to the Redevelopment Plan for Parcel A, which is adjacent to Parcel E to the northwest, low income housing will be constructed. Existing concerns about children climbing fences into Parcel E, children playing in contaminated soils, increased incidences of asthma, exposure to volatile compounds, the potential for fire and/or explosions and other hazards associated with the industrial landfill, have been well documented.

Another issue of concern is that at numerous former military installations in San Francisco, following base closure, the sites were remediated at great expense and redeveloped to include public access. Examples include the Presidio, Fort Funston, Fort Mason, and Crissy Field. The location of these sites and other significant parks in the City is included in Figure 4-2. Note that the majority of large open-space and parks are in the north and west of the City. Given the general lack of parks and recreational outlets in the Hunters Point area, remediation and restoration of the shipyard, and specifically the replacement of the Parcel E industrial landfill with a publicly accessible wetland, provides an exciting opportunity to afford local residence with equivalent access to natural open-space. In addition, a storm water wetland at Hunters Point would enhance the connectivity of parklands along the shore line. A long-term recreational goal in the area is to develop parklands that wrap around the entire South Basin shoreline.

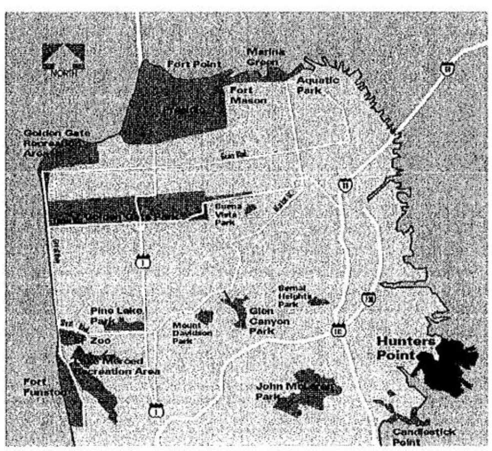



**Figure 4-2. Parks and Open Space in San Francisco**

### 4.6 Regulatory Constraints

The United States Clean Water Act (CWA) is the primary regulatory tool for the protection of natural wetlands and wetlands created for mitigation and water purification purposes (Hammer, 1991). Prior to construction of the conceptual wetland design, the proper selection and sequence of pertinent local, state and federal permit requirements must be determined.

The U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (U.S. EPA) decide on a case-by-case basis whether or not particular bodies of water are considered waters of the United States (Interagency Workgroup, 1999). Although wetlands intentionally created from non-wetland sites for the purpose of wastewater or storm water treatment are not normally considered waters of the U.S., discharges from constructed wetlands to waters of the U.S. must meet applicable NPDES permit effluent limits and state water quality standards (Hammer, 1991). Since the existing seasonal wetlands on Parcel E may be considered waters of the U.S. and discharge from a constructed wetland at Parcel E could enter San Francisco Bay, the construction of a wetland in Parcel E could fall under the jurisdiction of the CWA and the project will require fulfillment of CWA Sections 401, 402 and 404:

- **Section 401.** This section addresses Water Quality Certification. It verifies compliance with State or Tribal water quality standards. Section 401 verification is necessary when projects result in discharges to waters of the United States and require Section 402 or 404 permits (Interagency Workgroup, 1999).

- **Section 402.** Section 402, which includes the Storm Water NPDES program, is designed to regulate the discharge of a pollutant from a point source into waters of the United States. The state of California is authorized by the EPA to issue Section 402 NPDES permits. The construction of a treatment wetland at Parcel E would require a Section 402 NPDES permit if storm water captured by the proposed wetland is released to the San Francisco Bay (Interagency Workgroup, 1999; Hammer, 1991).

- **Section 404.** This section regulates discharge of dredged or fill materials into waters of the United States. A Section 404 permit would be required if the constructed wetland at Parcel E was built in the vicinity of a pre-existing wetland or riparian corridor. As stated above, the COE and the EPA decide on a case-by-case basis whether or not particular bodies of water are considered waters of the U.S. The COE administers section 404 permits, with advisement from the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (Interagency Workgroup, 1999).

Typically, wetland construction requires preparation of a California Environmental Quality Assurance (CEQA) Initial Study followed by a period of public review (Silverman, 1984). Additional permits that could possibly be required to construct engineered wetlands include: sediment and erosion control plans, dam safety permits, a Department of Fish and Game Stream Alteration permit, local grading permits, and land use approvals or encroachment permits (U.S. EPA, 1999).

In addition to the COE and EPA, other regulatory agencies typically involved in permitting for wetland construction in California include: US Fish and Wildlife Service; National Marine Fishery Service; California Department of Fish and Game; Regional Water Quality Control Board; and local Mosquito

Abatement and Flood Control Districts (Silverman, 1984). The Coyote Hills Demonstration Urban Stormwater Treatment (DUST) wetland in Fremont, California provides an example of the agencies and permits required for the construction of a storm water wetland in the San Francisco Bay area (Table 4-4).

**Table 4-4. Permits for the DUST Wetland in Fremont, California (Silverman, 1984)**

| Agency/Permit | Permit Requirement |
|---|---|
| State Determination of Environmental Significance | CEQA initial study, adopted negative declaration (conditional) on environmental impacts |
| Army Corps of Engineers Section 404 Permit | Conceptual Plan. Approved CEQA initial study and negative declaration. No net loss of wetlands. |
| Department of Fish and Game Stream Alteration Permit | Minimize disturbance and environmental degradation. Protect water quality. Limited construction period to protect fish and wildlife. |
| City of Fremont Grading Permit | Exempt due to lack of fill or export to the site. |
| Alameda County Flood Control and Water Conservation District Encroachment Permit | No reduction in storage capacity or obstruction to flow. |

Any constructed wetland in Parcel E at Hunters Point shipyard would need to comply with a similar list of agencies and permits outlined in Table 4-4. Of greater concern is the need to address existing contamination at the site, the presence of the industrial landfill, and potential for future releases from the landfill. Replacement of the landfill with a wetland could greatly reduce the potential for future contaminant releases while providing recreational opportunity for the Hunters Point community, improve storm water released to the bay, polish wastewater effluent, and create habitat for wildlife.

# 5.0 WETLAND DESIGN FEATURES

## 5.1 Introduction to Wetlands

Wetlands are land areas inundated by fresh, ground, and/or salt water for at least a portion of the growing season. These saturated conditions produce a unique ecosystem characterized by specific types of soils, vegetation, hydrology and wildlife. Wetlands contain saturated or hydric soils characterized by anoxic conditions, which produce soil of a distinctive gray color and fine texture. Hydrophilic plants are adapted with specialized structures that enable them to transport oxygen to their roots and thus thrive in the oxygen-deficient soils typical of wetlands (Hammer, 1989).

Wetlands are among the most biologically productive natural ecosystems in the world and provide a variety of life enhancing benefits. Wetlands cleanse waters of nutrients and toxins, prevent flooding by providing storage of floodwaters, provide open space for aesthetics, education and recreation, and provide essential habitat for many species of plants and animals, including rare and endangered species and migratory birds (U.S. EPA, 2002).

Wetlands are characterized as permanent or seasonal, and as fresh, saline or brackish. Permanent wetlands are continuously flooded with water and provide year-round habitat for migratory and permanent wildlife species. Seasonal wetlands are periodically flooded with surface water early in the growing season and generally dry out each spring or summer. Seasonal wetlands provide benefits of both flooded and mudflat habitats throughout the year. As spring dewatering occurs, mudflat conditions tend to prevail attracting migrant shorebirds and ducks. Freshwater wetlands receive water from surface runoff and/or freshwater groundwater discharge. In contrast, tidal wetlands are regularly exposed to the ebb and flow of the tides and can be either salt water or brackish. Plants that live in saline wetlands have special adaptations to withstand tidal action and high salinity.

## 5.2 Design Features to Enhance Bird Habitat

An established wetland system will provide food and habitat for a diverse population of plants, birds, fish, small mammals, and invertebrates. Some of the animals attracted to a constructed wetland will become permanent residents while others will be seasonal and migratory visitors (Dawson, 1989). Constructed wetlands can be especially beneficial for waterfowl. For example, the constructed freshwater wetland at Mount View Sanitation District, California, is populated with more than 123 species of birds (U.S. EPA, 1993 and 2002). Given Hunters Point's location on the Pacific Flyway, it is especially important that any wetland design create habitat to support both resident and migratory birds. A number of design attributes that can improve waterfowl habitat in a constructed wetland are discussed briefly below.

**Structural Complexity.** Structural complexity is one of the most important design features to enhance wildlife habitat in a constructed wetland. A successful constructed wetland will have a combination of open water areas with depths greater than 4 to 6 feet, and shallow marsh areas less than 2 feet in depth where emergent vegetation will grow. Several small cells rather than one large marsh tend to promote wildlife use of a wetland, as well as providing for better water treatment since short circuiting is inhibited. Shorelines should be irregular in shape and islands within ponds can provide ideal bird habitat.

**Vegetation**. Vegetation has a major influence on bird habitat, and a variety of vegetation is needed to support diverse wildlife and bird populations (Fredrickson and Reid, 1987). Aquatic plants within the wetland are classified as emergent, floating and submerged (Dawson, 1989). Emergent plants grow up and out of shallow water. They transfer oxygen to the root zone and provide habitat and food for birds and other animals. Emergent plants frequently found in constructed wetlands include cattails, reeds, rushes, bulrushes, and sedges. Floating plants have leaves that are on the water surface while their roots extend into the water column. Floating plants can reduce sunlight penetration and limit the growth of noxious filamentous algae in the water column. Examples of floating aquatic vegetation include water hyacinth, duckweed and pennywort. Submerged aquatic plants grow underwater and common species include milfoil and watercress. The practical use of submerged aquatics in constructed wetlands is limited since they tend to be shaded out by floating plants and algae and/or inhibited by anaerobic conditions common in wetlands (U.S. EPA, 1988).

Wetland design should also incorporate terrestrial plants, including trees and shrubs, located near the shores of the wetland system. Terrestrial plants provide food, nesting habitat, shade cover, windbreaks and habitat (Dawson, 1989). Dense uniform terrestrial cover crops can be used for erosion prevention on overland flow slopes and levees (Metcalf and Eddy, 1991). Open grassy areas should be limited since they tend to attract unwanted species such as geese.

**Water Depth.** The availability of appropriate water depths is an important element of effective waterfowl management. In keeping with the concept of structural complexity, a range of water depths should be incorporated into a constructed wetland. Shallow water, less than a foot deep, is essential for wading birds to foraging. Loafing strips, long and thin areas of very shallow water, provide ideal resting and foraging habitat for birds. Foraging can be further enhanced by slowly drawing down water level in ponds. This exposes benthic biota which facilitates feeding by shore birds. Ducks and diving birds are adapted to deeper bodies of open water where visibility is good and vegetation is sparse.

**Islands.** Islands provide waterfowl with ideal resting habitat that is protected from predators and provides the birds with clear line of site. Loafing strips, long and thin areas of very shallow water, can be connected to islands and provide birds with excellent resting, nesting and foraging habitat.

### 5.3 Physical Design Factors

An artificial wetland can be constructed with many different physical features. These features depend on the geographical location, seasonal weather conditions, and the purpose for which the wetland is designed. However, all wetlands must contain structures which will conduct water into and out of the system, control water flow, physically contain the water, and provide the means to fulfill specific process requirements. Such structures include, but are not limited to, single and multiple port entry devises, baffling structures, pond configurations, berms, dikes, and vegetation. Under some conditions, as at Hunters Point, a liner may be required. All of these features serve a combination of purposes which interact to produce a complex and viable artificial wetland capable of treating wastewater streams and urban runoff while providing food and habitat for wildlife. A brief discussion highlighting some of these design features is included below.

**Wetland Configuration.** Three different configurations are generally used in constructed wetlands: series, parallel, and a combination of parallel and series. The series configuration utilizes wetland cells in series while the parallel configuration splits inflow into a number of cells in parallel. In general, the more cells that water passes through, the better the removal of pollutants. All constructed wetlands should have at least two parallel cells so that one can operate while the other is shut down for maintenance. Two important features in wetland construction are to avoid "blind spots" in corners where water will stagnate, and to maintain good bottom uniformity to minimize channel formation and prevent short circuiting. Gravity is the favored method for transporting water through a wetland system, and where possible, the system should be designed to follow natural topography that facilitates gravity flow.

Many designers recommended a forebay/pond/wetland system for treatment of urban runoff (Walesh, 1989; U.S. EPA, 1999). The first component of this system, the sedimentation forebay, consists of a small area into which the influent flows. Debris and large particulates settle out of the water by gravity and collect at the bottom of the basin. The forebay acts to decrease the velocity of water entering the wetland and to decrease the sediment loading to the subsequent pond/wetland system. Many pollutants in urban runoff are attached to particulate matter, thus the forebay captures these particle-related pollutants before they reach the wetland. Adequate access to the forebay is needed so that equipment can enter and remove any polluted sediment that accumulates in the forebay. The forebay is followed by a pond/wetland system which provides a wide range of water treatment capabilities and aquatic habitats for wildlife.

**Flow Control Structures.** Once the influent has been brought to the wetland site, it must be introduced to the wetland and transferred between wetland cells in a controlled manner. Piping is normally used as an influent conductor when the influent is already contained, as from a wastewater treatment facility. Additional inlet/outlet structures include single port entry structures like weirs, and gates, as well as multiple port entry structures such as perforated piping. Multiple port entry structures are preferred over single port entry structures because they provide more even flow rates and influent distribution. One of the simplest multiple port structures is perforated piping. Influent conducted to the perforated pipe flows out into the wetland system through openings in the pipe which run the width of the system.

Weirs and gates are single port entry structures used to measure and control flow where the water surface can remain free (Grant, 1989). Weirs can be constructed in many different configurations including U-shaped, V-notched, parabolic, trapezoidal and truncated triangular. The shape and size of the opening determines the flow rate of the effluent. A gate structure may be a manually operated structure as simple as a sheet of plywood which can be lifted or lowered to release of retain effluent flow, or a sophisticated automated devise. The primary difference between weirs and gates is that gate structures have the ability to block the flow of water while weirs can only measure or direct the flow rate. Gates tend to be used as flood control and drainage/draw-down devises, while weirs generally serve as entry/outlet ports into and between pond cells.

The removal of pollutants can generally be increased by increasing the detention time. This is accomplished by forcing the influent to take a more meandering course through the wetland. This may be accomplished by installing baffles (U.S. EPA, 1983). Baffles are structures that cause the direction and velocity of the flow to change. A baffle can be a small earthen "island" placed in the path of influent flow which diverts the fluid to either side, or it can be a submerged fence. Easy installation and low cost have made the latter method popular. The same effect caused by baffling can be achieved by the configuration of the wetland system. Wetland cells can consist of several shallow canals rather than large, wide ponds. The channels will have the same effect on the flow pattern of the influent as baffling.

**Levees.** One of the largest components of constructed wetlands is the levees that surround and contain the water. Associated apparatuses are also designed to limit damage to wetlands such as rodent burrowing, seepage, or erosion that could damage the levee. The basic component of constructed wetland levees is soil. Soil is mounded and compacted to a specified height and width. In wetlands where the soil is high in clay and rests upon a deep foundation of mud, extra care and maintenance must be taken to construct the levees. At these sites, levees should have a wide base and may need to be continually raised to compensate long-term subsidence caused by the compression of the underlying soils (U.S. EPA, 1983).

The sides of the levee are carefully graded to promote vegetation growth while still retaining water. The percent grade used for a given levee will depend upon topographical features of the site, soil composition, vegetation selection, and the intended purpose of the constructed wetland. The exposed surfaces of the levee need to be protected from rain, wind, and wave erosion, as well as from burrowing animals. Rip rap is commonly used for these purposes. Rip rap are pieces of rock or broken concrete which are carefully laid across the exposed surface of the levee. If rodent burrowing and wind and rain erosion are not a serious problem, then the exposed surfaces of the levee may be covered with grass.

**Vegetation.** Vegetation and microbial organisms purify water in several ways. Plants will take up many pollutants through their roots and store them as biomass. Plants, both dead and alive, also provide surface area and carbon for microbial growth and the physical filtration of suspended particles. Two different categories of microbes generally exist in wetlands: aerobic organisms that thrive in high oxygen conditions and anaerobic bacteria that live under no-oxygen conditions. An example of these two types of microbes working together in wetlands is the nitrification/denitrification process which converts ammonia to nitrate (aerobic microbes) and nitrate to nitrogen gas (anaerobic microbes). This process removes nitrogen in the form of ammonia and/or nitrate from the aquatic ecosystem and transfers it as nitrogen gas to the atmosphere, thereby purifying the water traveling through the wetland.

When constructing a wetland, suitable provisions must be made to optimize growing conditions for these functioning flora. Structural considerations to promote vegetative and/or microbial growth include providing both shallow areas with gradual bank slopes for emergent vegetation such as cattails and bulrushes, and deep areas of water to promote anaerobic bacterial growth. In addition, large surface areas of water can provide adequate air to water oxygen transfer for fish and aerobic bacteria.

### 5.4 Wetland Liner and Reuse of Landfill Cap

Seepage into or out of a constructed wetland is not a desirable occurrence. Seepage results in fluctuations in the water depth and can cause pollution of groundwater (U.S. EPA, 1983). It is common practice in treatment pond design to assume that natural sealing will occur at the bottom of the wetland. Sealing can occur by a combination of mechanisms including physical clogging of soil pores by settled solids, chemical clogging of soil pores by ionic exchange, and organic clogging caused by microbial growth at the pond bottom.

In the case of Hunters Point, a liner system should be considered due to the presence of contaminated ground water and soils at the site. The conventional solution to seepage problems in treatment ponds and lagoons is the use of synthetic liners. While this method provides very good isolation between a wetland and underlying soils and groundwater, it can be expensive. Well-compacted clay soils can also provide adequate isolation between surface and ground waters at much lower costs. The section below discusses the potential for the reuse of soils already on site to fill in the excavated landfill after removal of the waste, and to construct a liner to protect the wetland from potential contamination from underlying groundwater and soils.

The recently installed landfill cap provides a source of clean fill that can be used during wetland construction, and this will preclude the need for the importation of large amounts of clean soil onto the site to construct the proposed wetland. Figure 5-1 shows a schematic of the wetland construction process. Generally speaking, the current landfill sits atop bay mud and is covered with a layer of native sand/clay and a landfill cap (Tetra Tech, 2003b). Ground water flows through the waste area. During excavation and construction, clean soils from the landfill cap and underlying sand/clay should be segregated and stockpiled on site for later use. Once the landfill waste is removed, the native sand/clay, presuming it meets soil quality objectives, can be placed in the excavation area. The clean soil from the landfill cap would then be used as the base for a wetland.

As described in Section 4.4 (Landfill Issues) the landfill waste covers approximately 20 acres and has an average thickness of around 15 feet. Removal of the landfill waste would result in an excavated area roughly 20 acres in surface area with a base elevation of 5 to 10 feet below mean sea level. Native clay/sand currently on top of the landfill could be placed in the excavated area and bring the base elevation up to approximately sea level. If the permeability of the native clay/sand is not low enough to isolate the wetland from the ground water, a clay liner could be installed on the clay/sand. The clean soil from the landfill cap would then be placed on top of the native clay/sand, thereby raising the elevation by roughly an additional 5 feet. Additional clean fill may be needed for the construction of the levees around the wetland.

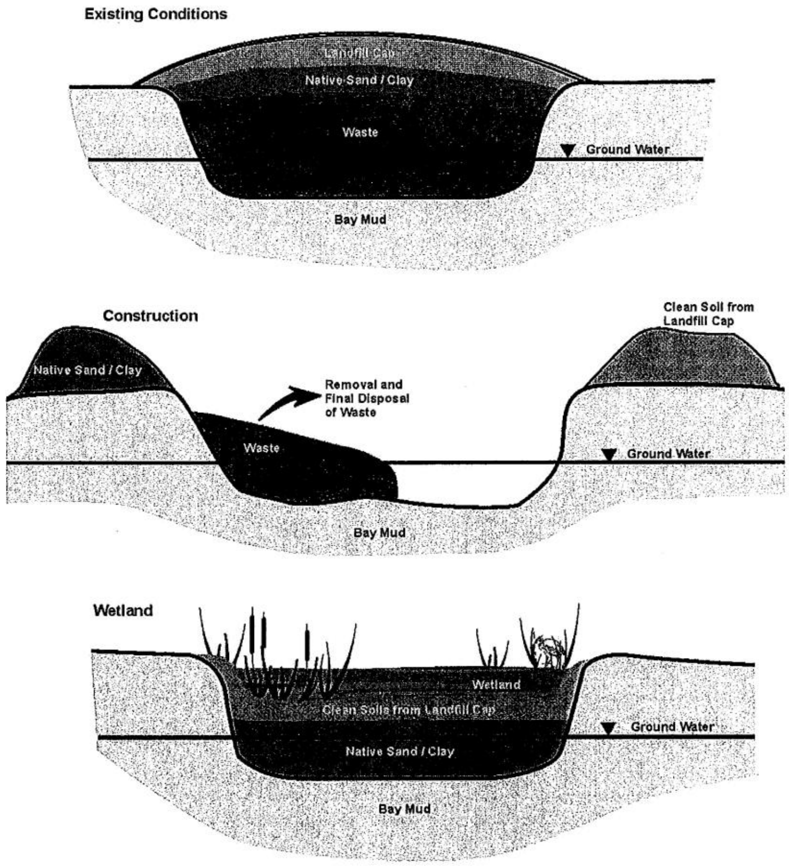



**Figure 5-1. Schematic of Reuse of Landfill Cap**

### 5.5 Mosquito Abatement

Although there is public concern about mosquito outbreaks resulting from constructed wetland projects, wetlands can be designed and maintained to keep mosquito populations to a minimum. Mosquitoes lay their eggs on or near the water and the mosquito larvae live on the water surface, breathing air and feeding primarily on algae and organic debris (Borror, 1976; Metcalf and Luckman, 1975). Minimizing hydraulically static areas, controlling water level, disturbing water surface to drown larvae, minimizing anaerobic zones, and creating access for natural mosquito predators are common mosquito control strategies. Some of these strategies are discussed in further detail below.

Water level manipulation and topography control are two commonly used control mechanisms. The periodic drawdown of the water surface in a wetland can eliminate habitat for most mosquito species and can be timed for key periods in the insect's life cycle (Collins and Resh, 1989). Wetland topography should be constructed to avoid ponding of water in isolated areas during drawdown. In addition, deep pools should be provided to ensure sufficient habitat for fish during the dry season when wetland water elevation may be minimal (Silverman, 1984).

Wetland vegetation, although beneficial in other ways, can provide larvae with refuge from water surface disturbances and predators, and can decrease developmental time by increasing habitat temperature and enhancing food resources. Vegetation selection plays a key role in mosquito management. Dense patches of free-floating vegetation (i.e., duckweed and water fern) which totally cover the water surface inhibit mosquito egg laying. In contrast, water hyacinths, pickleweed and pondweed appear to support large populations of mosquito larvae (Collins and Resh, 1989). Appendix G includes a copy of an assessment of wetland plant of the San Francisco Bay Area in relation to the ecological control of mosquitoes from by Collins and Resh (1989).

The addition of fish to a wetland is commonly used as a natural method to control mosquito populations. The mosquito fish (*Gambusia affinis*) is the most widely used biological control agent and is harvested for mass inoculation into wetland systems. Sunfish (*Lepomis spp.*) and stickleback (*Gasterosteus spp.*) are two additional species that can enhancing mosquito control efforts. The three different fish species will inhabit different niches within a wetland/pond system, thereby providing comprehensive protection against mosquitoes (Collins and Resh, 1989). Adequate dissolved oxygen concentrations and low ammonia levels should be maintained in the wetland to make the aquatic environment hospitable to fish (Tchobanoglous, 1987; Horne, Personal Communications). Oxygen is required for the fish to breathe, while ammonia can be toxic to fish. Oxygen levels can be maintained mainly by limiting organic loading to the wetland. Recycled water from domestic wastewater treatment plants is generally of adequate quality to support fish in a wetland.

Neither the City nor County of San Francisco have a dedicated mosquito abatement district that is responsible for the control and monitoring of mosquitoes. Mosquito abatement in the City is handled by the San Francisco Department of Public Health. The nearby San Mateo County Mosquito Abatement District (SMCMAD) controls and monitors harmful pests, including mosquitoes, in San Mateo County. A representative from the SMCMAD is available for a preliminary site visit and to review the wetland design plans to ensure a mosquito source is not created at Hunters Point (Peavey, Personal Communications).

## 6.0 WETLAND ALTERNATIVE SELECTION AND CONCEPTUAL DESIGN

### 6.1 Objectives of Wetland at Hunters Point Shipyard

Based on dialog with the staff at the GGAS, we identified three main objectives for wetland creation at Hunters Point:

- Provide opportunities for public education, access, and recreation.
- Create marsh habitat for desirable birds and aquatic biota.
- Improve the quality of storm water and wastewater effluent prior to discharge to San Francisco Bay

An overarching goal of the project was also to provide an alternative vision for the use of the area in Parcel E now containing an industrial landfill. The proposed location of the wetland described in this study is the area currently occupied by the landfill, and this conceptual design assumes the prior removal and final off-site disposal of landfill waste.

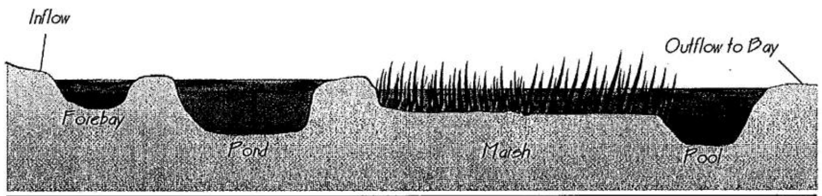
### 6.2 Wetland Alternatives Analysis

Constructed treatment wetlands generally fall into one of two conceptual types: the free water surface wetland, and the subsurface flow wetland (Reed *et al.*, 1995). In a free water surface wetland, the water surface is in contact with the atmosphere in basins that can be variable in depth. In a subsurface flow wetland, the water surface is maintained below the surface of a porous media that is contained in an excavated basin or trench. Table 6-1 compares these two wetland types with respect to ability to meet the project objectives stated above. For obvious reasons, a free water surface wetland is the preferred option available at Hunters Point.

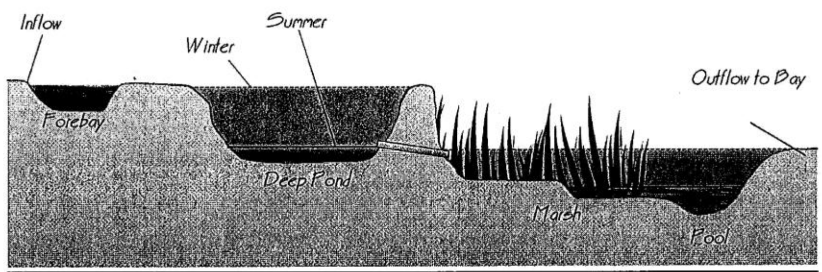
**Table 6-1. Comparison of Free Water Surface and Subsurface Flow Wetlands**

| Characteristics | Free Water Surface Wetland | Subsurface Flow Wetland |
|---|---|---|
| Public recreation | Available as open space | Minimal |
| Wildlife habitat | Refuge and nesting areas, and food sources available for fish and birds | Minimal |
| Vegetation types | Emergent, submerged, floating aquatic vegetation habitat available | Minimal |

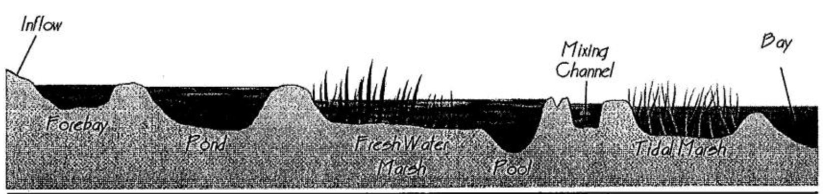
Additional considerations in the conceptual design of a wetland include whether the wetland will be a seasonal or permanent wetland, and whether the wetland will include freshwater, brackish water, and/or saltwater wetland cells. For this alternative analysis we evaluated three alternatives: a permanent freshwater wetland (Alternative 1), a seasonal freshwater wetland (Alternative 2), and a permanent freshwater/tidal wetland (Alternative 3). Figure 6-1 shows a schematic of these three alternatives.




Alternative: Permanent Fresh Water Wetland




Alternative 2: Seasonal Fresh Water Wetland




Alternative 3: Permanent Fresh Water / Tidal Wetland

**Figure 6-1. Hunters Point Wetland Alternatives**

Each of the three alternatives has several features in common. Inflow first discharges into a forebay. The forebay acts as a basin for settling of suspended solids. An added benefit of the forebay is that it can be dredged if the sediment load is excessive. After the forebay is a pond. Ponds provide open-water zones that are accessible to birds and wildlife. Ponds also enhance treatment benefits by increasing retention time in the wetland. Marsh areas follow the ponds. Marsh areas enable the growth of emergent vegetation that can be utilized by wildlife as a food resource, and for nesting and resting space. In addition, emergent vegetation is an attachment substrate for bacteria that are active in the removal of pollutants present in the inflow. Pool areas in the marsh provide a refuge for fish during low flow periods. They are of particular importance when water level manipulation is needed or, in seasonal wetlands during months when water surface levels are reduced. The feasibility of each alternative is assessed below.

**Alternative 1 – Permanent Freshwater Wetland.** In the permanent freshwater wetland alternative, storm water and recycled water flow into the forebay, and are gravity fed to the pond, which flows into the marsh/pool cells. The marsh overflows to San Francisco Bay. In Alternative 1, water levels will be maintained in all wetland components throughout the year through the use of recycled water. Hydraulic structures to allow drawdown of the water level to optimize operations will be provided.

Based on a review of project objectives, the permanent freshwater wetland system is the preferred alternative for Parcel E at Hunters Point. It is the only alternative that meets the multiple project objectives: providing high-quality year-round recreational opportunities to the community; providing optimal year-round habitat for a range of resident and migratory populations of fish, birds and other wildlife; and providing a year-round mechanism for improving storm water prior to discharge to the Bay. Additionally, with a permit from the National Pollutant Discharge Elimination System NPDES, these wetlands could also receive recycled water.

**Alternative 2 – Seasonal Freshwater Wetland.** In this alternative, stormwater flows into the forebay and then is gravity fed to the pond/marsh system. Since input to the wetland will depend on precipitation and runoff in the watershed, the pond water level will fluctuate from summer to winter months. This requires construction of a larger and deeper pond to store storm water. Storm water from the pond will discharge into the marsh and pool over the spring and summer, followed by discharge into San Francisco Bay. The water level in the pond is expected to drop considerably, resulting in the need for a hydraulic structure to convey water from the deep pond to the marsh.

While this alternative is feasible, it does not fully meet the objectives for the project. Since the pond and marsh would be dry in the summer, it would not provide for a year-round aesthetically pleasant recreational resource for surrounding inhabitants. In addition, this alternative does not utilize the treatment capacity of the wetland to improve the quality of recycled water before it is discharged to the Bay.

**Alternative 3 – Permanent Freshwater/Tidal Wetland.** In the permanent freshwater/tidal wetland alternative, inflowing storm water and recycled water follows the same path as described for Alternative 1, with the exception that outflow from the marsh/pool will flow into a mixing channel where it will combine with incoming saltwater from San Francisco Bay during periods of high tide. The use of flap gates or unidirectional valve structures will direct the mixed water into the tidal marsh cell, which is hydraulically connected to San Francisco Bay.

This alternative is not recommended at Hunters Point due to contaminated sediments, including PCBs, in Parcel F, the submerged area of the Bay just offshore of Parcel E. We are concerned that contaminants could be resuspended and transported into the tidal marsh area. This could potentially lead to the contamination of biota if the pollutants biomagnified up the food chain within the wetland. In addition, this alternative would need to have relatively complex water control structures and operational procedures which make it less attractive.

### 6.3 Conceptual Design of Preferred Alternative

Figure 6-2 shows the conceptual design developed by the project team for a permanent freshwater wetland in Parcel E of Hunters Point. Note that not all facilities in Figure 6-2 are to exact scale. The design includes a series/parallel configuration in which water passes through two parallel systems that consist of multiple cells in series. The wetland includes a forebay/pond/wetland treatment train which provides a wide range of treatment capabilities and wildlife habitats. Water first flows into the Forebay. From the Forebay, water is distributed to the Wading Bird Pond to the south and to the Dragonfly Pond to the east. Water then flows from the Wading Bird Pond to Wetland Cell 1 and from the Dragonfly Pond to Wetland Cell 2. Both wetland cells discharge to the San Francisco Bay. Components of the proposed permanent freshwater wetland are discussed in greater detail below.

**Forebay.** Inflow, consisting of storm water during the winter and recycled water during the spring, summer and fall, would first enter a forebay roughly one-half acre in surface area. The forebay acts to capture particulates which commonly have pollutants attached to their surfaces. Since sediments and storm water from Parcel E have been shown to be contaminated, containment of particles in the forebay is an important water treatment goal. The forebay would have fairly steep edges and a deep bottom to inhibit plant growth and the use of the area by wildlife. The forebay would include an access ramp to facilitate removal of sediments as needed. The forebay would also act to slow inflowing storm water and to distribute water to the two treatment trains, one to the east of the forebay and the other to the south of the forebay.

The forebay inlet structure should be designed to divert extreme flows events away from the forebay to the existing seasonal wetlands south of the proposed wetland. This would limit the potential for resuspension of sediments in the forebay due to high turbulence, and the possible transport of contaminated sediments out of the forebay and into the pond/wetland system. The inlet structure could also be used to discharge the more polluted "first flush" of the storm water to the forebay, and into the pond/wetland system for additional treatment. Subsequent storm water could be discharged to the seasonal wetlands to enhance water quality and habitat in these wetlands.

**Ponds.** After the forebay, water flows into two ponds: the Dragonfly pond to the east and the Wading Bird Pond to the south. Each pond would be around three acres in surface area and six feet in depth. The water elevation in the east pond would be held constant. This would permit the growth of aquatic plants and the development of a pond food web which would support insects, thus the name "Dragonfly" Pond. The insects would support various types of insect-eating birds. Water elevation in the Wading Bird Pond would be slowly drawn down then refilled every four to six weeks during the spring though fall. This would expose benthic animals growing in the sediment, thereby facilitating foraging by wading birds.

Both ponds would contain an island with a loafing strip that would provide nesting, refuge and foraging habitat for birds. The islands would also act as berms, splitting the pond into two effective treatment cells, thereby inhibiting short circuiting and promoting water treatment. The ponds would also include a predator trench, roughly 8 feet deep and 20 feet wide, around the submerged circumference of the ponds to prevent land predators from getting into the ponds and onto the islands.

**Wetland.** Both ponds discharge to a separate wetland cell, each roughly seven acres in surface area. The wetlands would be fairly shallow to allow for the growth of emergent vegetation such as cattail and bulrush. The depth of the wetland would increase near its center to exclude emergent vegetation, and this would result in the creation of pools. By incorporating a complex topography into the wetland, various depth zones will be created, thereby maximizing plant diversity, wildlife habitat, and pollutant removal capacity. Berms made of earth or of wood could be installed under or as part of the structure of the boardwalks that cross each of the wetland cells. This would split the wetlands into two effective treatment cells, thereby inhibiting short circuiting and promoting water treatment.

The wetland should include native aquatic plant selections that will provide a wide range of habitat and food resources for wildlife. Plant selection can also be based on desired effluent qualities if the wetland is a treatment wetland. In addition, local climate (Dawson, 1989) and hydroperiod (Zimmerman, 1988) should be considered during plant selection. Appendix G includes a list of native plant species available for inclusion in a detailed wetland design.

**Hydraulic Connections.** Hydraulic connections will be installed between treatment cells, and under typical operation water will flow from the forebay to the two ponds, then from each of the ponds to the subsequent wetland cell. In addition to these standard connections, there are additional connections that would be closed under standard operating conditions, but would provide wetland managers with operational flexibility in moving water around the system during times of emergency or maintenance. For example, there are proposed hydraulic connections between the two ponds, between the Dragonfly Pond and Wetland Cell 1, and between the two wetland cells near the outlet to the Bay.

**Public Access.** Public recreation and utilization of the wetland is a primary goal of the project, thus public access is an important component of wetland design. Figure 6-2 includes a number of public access features. The public would access the wetland via a single entrance point located on the levee between the Dragonfly Pond and Wetland Cell 2. Boardwalks would be included along most of the levees between the ponds and wetland cells, and would also extend into the wetlands themselves. A number of observations decks with informational kiosks could also be included along the boardwalks. The boardwalks and observation desks would provide an ideal vantage point from which to unobtrusively observe wetland plants and wildlife.

A wetland center near the public entrance to the wetland could be used to educate the public concerning the importance of wetland ecosystems. Office space should also be provided for volunteers to monitor and quantify bird use of the wetland, an important parameter in evaluating the success of the wetland system. In addition, a blind, a viewing area camouflaged to birds and wildlife, could be attached to the wetland side of the wetland center to allow for supervised, all-weather viewing of wetland biota.

### 6.4 Construction and Operation and Maintenance Costs

Unit costs for wetland construction range from $40,000 per acre for a wetland of moderate complexity, to $75,000 per acre for a wetland of higher complexity (*e.g.,* bottom liner, planting of specified species) (Kadlec and Knight, 1996). At Hunters Point, there should be savings associated with earth moving, since it is assumed that the landfill would be removed. It is expected, however, that a liner composed of synthetic material (Appendix H) or of low permeability soils, perhaps reused from the current landfill cap, would be needed to isolate the wetland from potentially contaminated groundwater. Based on these assumptions, an estimated unit cost for the Hunters Point Wetland is around $50,000. Assuming a 20 acre wetland, total construction costs are estimated at $1 million. In comparison, the 38 acre Arcata, California, wastewater treatment wetland cost around $1 million to construct ($24,500 per acre), while the 24 acre Gustine, California, wastewater treatment wetland cost $1.6 million to construct ($66,700 per acre). All costs noted here are in 2003 dollars.

The construction costs cited above include clearing brush, erosion control, excavation, staking and grading, and planting. After the development of a conceptual wetland design and buy-in from local stakeholders, design and permitting costs are typically around 10% of construction costs; a final design/permitting fee should be around $100,000.

Various sources cite operation and maintenance (O&M) costs of $600 per acre for a "median" wetland, 2% of construction costs, or $5,000 to $50,000 (Kadlec and Knight 1996; U.S. EPA, 1999). O&M costs include pumping energy, basic compliance monitoring, dike maintenance, equipment replacement/repair, boardwalk and signage maintenance, and nuisance control (e.g., mosquitoes, gophers, bottom fish). The $600 per acre factor would yield $12,000 per year, while the 2% factor would yield $20,000. Note that more sophisticated compliance monitoring or study costs could add up rapidly. Due to the contaminated nature of the stormwater and the wetland site, water and sediment monitoring costs could result in much higher annual costs. It is recommended that cost estimates assume a $20,000 per year value, plus an additional $20,000 for water and sediment monitoring. This yields a net annual O&M cost of $40,000 per year as a rough O&M estimate.

Note that the estimated O&M costs for the wetland, around $40,000 per year, are far below the current O&M costs associated with management of the industrial landfill. Current O&M activities include pumping and maintenance associated with the sheet pile groundwater extraction system on the southeast border of the landfill, pumping and maintenance associated with the gas extraction and treatment system on the north border of the landfill, and watering and mowing of 16 acre landfill cap. While we have not seen precise cost estimates for these ongoing activities, they likely exceed $400,000 per year. Additional construction and O&M costs will be incurred if a subsequent vertical barrier is installed along the northern edge of the landfill. If the landfill was removed and a wetland was constructed in its place, total annual operating costs would decrease substantially, while recreational options, wildlife habitat, and water quality of waters discharged to the Bay would increase.

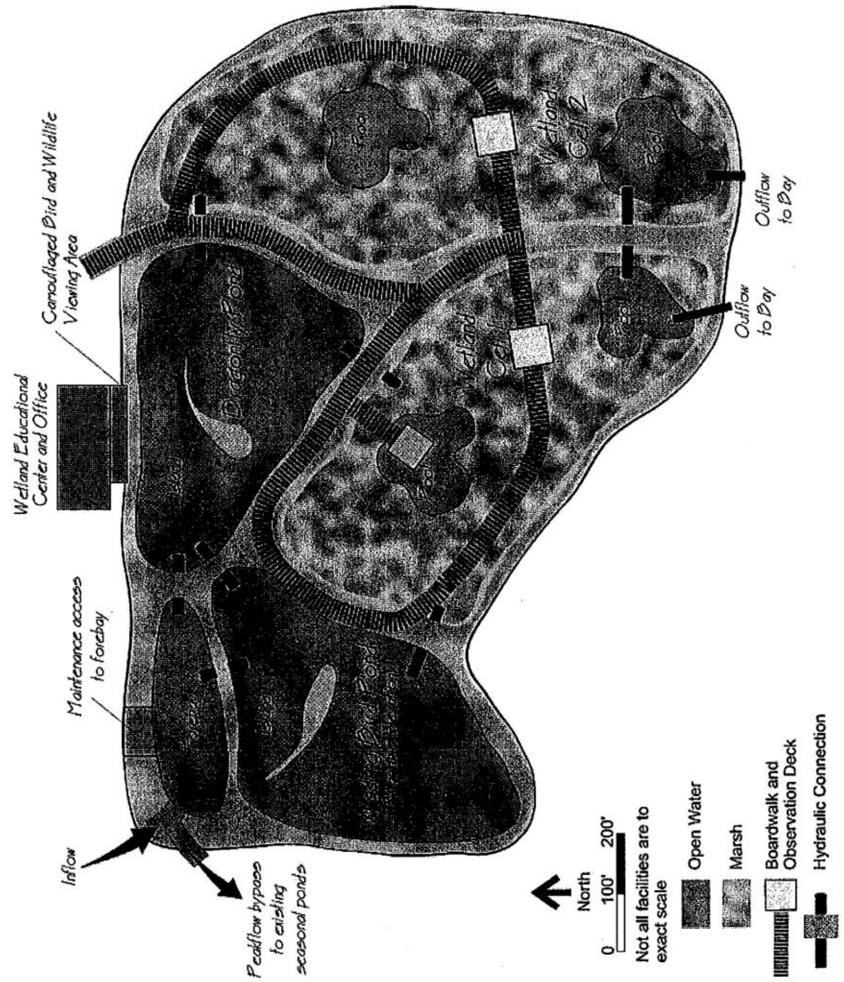



**Figure 6-2. Conceptual Design of Permanent Freshwater Wetland at Hunters Point**

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides a number of conclusions based on this study, and some specific recommendations regarding implementation of a storm water wetland in Parcel E of the Hunters Point shipyard.

### Conclusions

- The development of new wetlands in Parcel E will comply with several of the guidelines set forth in the Hunters Point Shipyard Citizen's Advisory Committee redevelopment plan, including: a balance between development and environmental conservation by providing wildlife habitat, integration of land uses by expanding open space, and improved public access by promoting recreational opportunities at a natural wetland area.

- Surface water and sediment data indicate that runoff and soils from Parcel E are high in contaminants and may result in deleterious impacts to water quality in San Francisco Bay. A properly constructed and operated wetland could result in an improvement in water quality in the San Francisco Bay by capturing and treating pollutants and sediment in storm water before they reach the Bay.

- Several issues exist related to the ability of the industrial landfill to contain waste and not function as a source of continued contamination to the San Francisco Bay and adjacent parcels at Hunters Point. These issues include the lateral and vertical extent of the landfill, the potential for liquefaction, and the construction and/or extent of the landfill cap. Many of the issues and uncertainties would be ameliorated if the landfill was removed and replaced with a wetland.

- A permanent freshwater wetland system was determined to be the preferred alternative for Parcel E at Hunters Point because it is the only alternative that meets the multiple project objectives: providing high-quality year-round recreational opportunities to the community; providing optimal year-round habitat for a range of resident and migratory populations of birds and other wildlife; and providing a year-round mechanism for improving storm water prior to discharge to the Bay.

- The conceptual design presented in this report includes a series/parallel configuration in which water passes through two parallel systems that consist of multiple cells in series. The wetland includes a forebay/pond/wetland treatment train which provides a wide range of treatment capabilities and wildlife habitats.

- Wetlands can be designed and maintained to keep mosquito populations to a minimum by eliminating hydraulically static areas, controlling water level, disturbing water surface to drown larvae, minimizing anaerobic zones, and creating access for natural mosquito predators.

- Assuming construction of a 20 acre wetland, total construction costs are estimated at $1 million in 2003 dollars. The net annual O&M cost is estimated at $40,000 per year. This estimated O&M cost is far below the current O&M costs associated with management of the industrial landfill, which likely exceed $400,000 per year.

**Recommendations**

- Remediation of the site should take into consideration the concerns and needs of the community living in and around the shipyard, with a focus on potential health effects associated with the location of an industrial landfill in their community, and return of the site to full use and accessibility by the public. Community input at all phases of the design and construction of a wetland should be solicited.

- Storm water and direct precipitation are adequate to keep the proposed wetland full from November through March. Make-up water is needed from April through October when evaporation is high and inflow is low. The total amount of make-up water required over the year is 46 acre-feet or 15 million gallons. The most suitable source of make-up water is recycled water from a satellite wastewater treatment plant proposed for the Hunters Point shipyard.

- A liner system should be installed between the wetland bottom and the existing soils on the site in order to isolate the wetland from contaminated ground water and soils. This liner may be constructed of clay or may utilize more sophisticated manufacture liners.

- A wetland sited on Parcel E could potentially receive contaminated storm water. This point should be considered in the design and operation of any wetland at the site since the wetland will be heavily used by wildlife, and the risk of contamination of wildlife must be minimized. Since many contaminants are attached to particles, a forebay with easy drainage and access capabilities should be included in any wetland design to capture, trap and remove sediment, and keep the sediment from entering the wetland.

- To save money and ease construction, clean soils already on site, including the landfill cover, should be used to fill in the excavated landfill after removal of the waste and to construct a liner to protect the wetland from underlying groundwater and soils.

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# APPENDIX A

## SUMMARY OF PUBLIC COMMENTS AND ISSUES RESULTING FROM THE JUNE 24, 2004 PUBLIC MEETING

**Summary of Public Comment and Issues Resulting from June 24, 2004 Public Meeting**

Following a presentation on the conceptual design for a constructed wetland on the site of the existing industrial landfill at Parcel E of the Hunters Point shipyard, the floor was opened for comments by the members of the public and the community. Following are comments, concerns and requests made at that time by three community members.

**Olin Webb**. Olin is a member of the Bay View Community Advocates group. He described his participation in a 2-week long class on watersheds, which he took so he could understand what was happening at the shipyard. He expressed his concern about the loss of fishing and shrimping along the shores of the shipyard, recalling earlier times when he and members of his community had access to the shoreline and fishing was a part of the community. He is also concerned about the capping of the landfill, and of the lack of protection for the people and the watershed.

**Oscar James**. Oscar spoke quite eloquently about what is and is not happening at Hunters Point. He wants to see all toxics removed from the area. He wants the shrimp and crabs to return to the waters adjacent to the site. He wants money provided to help send community kids to college so they can come back to the neighborhood and help clean it up. He approved of the involvement of high school students in the water quality work at Yosemite Slough, and would like to see more activities of the type. Oscar spoke of all the money spent so far at Hunters Point, and of how he sees no benefit to the community as of yet. He says all that money spent has not helped anyone in the community, and he wants it to.

**Tyrone Honory**. Tyrone recalled fishing at the shipyard when he was 12 years old, and he is now in his 50s. He wants to be able to fish again. He wants all the polluting that is going on to stop now.

# APPENDIX B

## SUMMARY OF MEETINGS FOR THE HUNTERS POINT STORM WATER WETLAND PROJECT

**Summary of meetings for Hunters Point Storm Water Wetland Project**

| | |
|---|---|
| Date of meeting: March 11, 2003 | Individuals Present: Arthur Feinstein, Marc Beutel, Rhea Williamson |
| Meeting Summary: Review of project goals and tasks. Discussion of data needs; identification of individual responsibilities: Copies of documents on constructed wetlands were distributed. Information was discussed on additional work (60 to 90% design), reports on Hunters Point were reviewed. | |
| Date of meeting: March 18, 2003 | Individuals Present: Rashmi Kashyap, Divya Ramachandra, Nohemy Revilla, and Rhea L. Williamson |
| Meeting Summary: Task assignments and paperwork for initiating the project were discussed. An initial web-based search was initiated to begin identifying sites to collect data from. Data sheets were discussed related to project documentation; these include phone log forms, work completion forms, and a data identification spreadsheet. | |
| Date of meeting: April 10, 2003 | Individuals Present: Arthur Feinstein, Saul Bloom, Steven Krefting, Jeff Marmer, Marc Beutel and Rhea L. Williamson |
| Meeting Summary: Saul Bloom provided a detailed overview of the Hunters Point project, with discussion of the involvement of the numerous players, including the Public Utilities Commission (PUC), Lenare Developers, the Technical Review Committee (comprised of Gearhart, Josslyn, Tchobanoglous, Jenkins, and Allen) and others. The Redevelopment Plan of 1997 was summarized, as was involvement by the City of San Francisco, the SF airport, the Navy and others. The expected cleanup levels were discussed (practical and per level of use) as were the need for community based cleanup levels. The landfill was discussed with respect to the fire, the RCRA compliant cap, and potential problems with the landfill. | |
| Date of meeting: April 24, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Wilfreddo Hoffer, Rashmi Kashyap, Nohemy Revilla, and Divya Ramachandra |
| Meeting Summary: 1) determine lead individuals on various tasks and subtasks (see below), 2) go over data collected to date, and 3) set some deadlines with respect to the schedule (not finalized). | |
| Date of meeting: May 12, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Wilfreddo Hoffer, Rashmi Kashyap, Nohemy Revilla, and Divya Ramachandra |
| Meeting Summary: 1) verify leads individuals on the various tasks and subtasks, 2) go over data collected to date, and 3) set some deadlines with respect to the schedule. | |
| Date of meeting: June 18, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, Nohemy Revilla, Divya Ramachandra and Marc Beutel. |
| Meeting Summary: 1) acquaint Marc and student workers, 2) go over data collected to date, 3) strategize on specific aspects of data collection and 4) set schedule deadlines. | |
| Date of meeting: July 16, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, Divya Ramachandra and Marc Beutel. |
| Meeting Summary: 1) Discussion of data needs (prepare precipitation plots, determine watershed area, schedule site visit, review Title 27 of CCR, determine runoff as a function of land use in the watershed), 2) identification of individual responsibilities, 3) copies of several documents were distributed including tables of Hunters Point water quality data, the final storm water discharge management plan, Parcel E wetlands delineation and function and values assessment document, SJSU draft report on HP, and 17 case studies on constructed wetlands, 4) set deadlines for the annotated outline and the compilation of data and information collected to date. | |

**Summary of meetings for Hunters Point Storm Water Wetland Project (continued)**

| | |
|---|---|
| Date of meeting: August 05, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra |
| Meeting Summary: 1) discussion of landfill area (14.8 acres of the total landfill area (20 acres?) is capped with an interim design, 2) brainstorm of reasons for landfill removal (source of contaminants to SF Bay, cap does not cover entire landfill, cap is not RCRA approved, problems with spontaneous combustion, aesthetics, and etc., 3) Rhea will contact Kevin Bricknell or Mike Wanta of Tetra Tech in San Diego at 619-525-7188. | |
| Date of meeting: August 13, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, Divya Ramachandra and Marc Beutel. |
| Meeting Summary: 1) discussion of data needs (preliminary outline of document, background cleanup levels, info on Parcel E and F), 2) distribution of several documents, 3) review of initial annotated outline, and 4) summary of the compilation of data and information collected to date. | |
| Date of meeting: August 27, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, Divya Ramachandra and Marc Beutel. |
| Meeting Summary: 1) discussion of data collected to date, 2) distribution of several documents, 3) review of preliminary document outline, and 4) summary of the compilation of data and information collected to date. Deadlines were set for several sections of the report. After Marc left, discussion followed on presentation in the SJSU Graduate Studies and Research Showcase of Excellence forum and on presenting at the CWEA Annual Conference. | |
| Date of meetings: September 10, 17, and 23 of 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra |
| Meeting Summary: 1) discussion of data needs, 2) summary of the compilation of data and information collected to date, and 3) answer questions. | |
| Date of meeting: September 25, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra from San Jose State University, Marc Beutel from Brown and Caldwell, Amy Brownell from the City of San Francisco Department of Public Health, Lucinda Rose of Tetra Tech, Wayne Akiyama of Shaw Environmental, and Patrick Brooks, who represented the US Navy |
| Meeting Summary: 1) site visit of the Hunters Point shipyard, Parcel E. Areas visited include the wetland areas, landfill, and drainage areas. Following the site visit, the project team (SJSU members and Marc Beutel) met to 1) discuss data collected to date, 2) review the deadlines previously set, and 3) go over the draft report that is in progress. | |
| Date of meeting: September 30, 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra |
| Meeting Summary: 1) met to discuss presentation of the Hunters Point Project at the San Jose State University Showcase of Excellence in Research. Poster tasks and assignments were made. | |

**Summary of meetings for Hunters Point Storm Water Wetland Project (continued)**

| | |
|---|---|
| Dates of meetings: October 8, 22, 27, and 8 of 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra |
| Meeting Summary: 1) discussion of report progress, 2) data needs, 3) poster preparation for the Showcase, 4) draft submittal reviews, 5) schedule of future tasks, and 6) other project related issues | |
| Date of meeting: October 29, 2003 | Individuals Present: Rhea L. Williamson and Marc Beutel |
| Meeting Summary: 1) The draft report was evaluated for completed sections, sections in need of additional information and areas of focus. The wetland design section was discussed with respect to the water balance (inflows and losses), wetland site characteristics, need for a forebay, potential reuse of cap materials for the wetland base, and design goals. In the latter, the importance considering wildlife habitat options that select for preferred species (*i.e.,* minimize geese/unwanted vegetation types), vector minimization, operational flexibility, community support, public access options, and stormwater transport of sediments and/or contaminants were discussed. | |
| Date of meeting: November 4, 18, and 25 of 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra |
| Meeting Summary: 1) discussion of report progress, 2) data needs, 3) poster preparation for the Showcase, 4) draft submittal reviews, and 5) schedule of future tasks. | |
| Date of meeting: December 18, and 22 of 2003 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and/or Divya Ramachandra. Meetings were with individuals due to schedule changes and conflicts related to the end of the semester. |
| Meeting Summary: 1) discussion of report progress, 2) data needs, 3) draft submittal reviews, 5) schedule of future tasks, and 5) other project related issues | |
| Date of meeting: January 14, 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) discussion of wetland objectives and design criteria, 2) review of data sources available. | |
| Date of meeting: January 19, 2004 | Individuals Present: Rhea L. Williamson and Divya Ramachandra. |
| Meeting Summary: 1) discussion of report progress with a focus on water quality needs. | |
| Date of meeting: January 20, 2004 | Individuals Present: Rhea L. Williamson and Marc Beutel. |
| Meeting Summary: 1) discussion of report progress with a focus on wetland design criteria. | |

**Summary of meetings for Hunters Point Storm Water Wetland Project (continued)**

| | |
|---|---|
| Date of meeting: January 20, 2004 | Individuals Present: Rhea L. Williamson, Marc Beutel, Arthur Feinstein, Jeff Marmer, Jack Lendvay. |
| Meeting Summary: 1) discussion of project progress with an overview of site characteristics, water quality, the water balance, need for an alternative water supply, and wetland design criteria. Wetland design focused on the concepts of a forebay, landfill cap soil reuse, need for a liner, and vector issues. 2) discussion of where we need to go focused on community involvement, wetland scenario schematics, and confirmation of the availability of an alternate water supply. | |
| Date of meeting: January 26 of 2004 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, and Divya Ramachandra. |
| Meeting Summary: 1) discussion of report progress, 2) sorting of reference materials related to wetlands into categories of design, performance, criteria, problem solving and others. | |
| Date of meeting: February 9 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) writing of summary information related to conceptual wetland design. | |
| Date of meeting: February 16 of 2004 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra. |
| Meeting Summary: 1) discussion of report progress, 2) delegation of tasks on liner, and liquefaction issues, and 3) writing of summary information on conceptual wetland design. | |
| Date of meeting: February 24 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) writing of summary information related to conceptual wetland design. | |
| Date of meeting: March 8 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) writing of summary information related to conceptual wetland design. | |
| Date of meeting: March 20 of 2004 | Individuals Present: Rhea L. Williamson and Rashmi Kashyap. |
| Meeting Summary: 1) writing/editing of conceptual wetland design section. | |
| Date of meeting: March 22 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) writing of summary information related to conceptual wetland design. | |
| Date of meeting: March 31 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) writing/editing of conceptual wetland design section. | |
| Date of meeting: April 12 of 2004 | Individuals Present: Rhea L. Williamson and Marc Beutel. |
| Meeting Summary: 1) discussion of conceptual wetland design, draft report. | |

**Summary of meetings for Hunters Point Storm Water Wetland Project (continued)**

| | |
|---|---|
| Date of meeting: April 13 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) writing of summary information related to conceptual wetland design. | |
| Date of meeting: April 15 of 2004 | Individuals Present: Rhea L. Williamson and Marc Beutel. |
| Meeting Summary: 1) discussion of conceptual wetland design, review of draft figures, overview of draft report. | |
| Date of meeting: April 17 of 2004 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra. |
| Meeting Summary: 1) preparation of PowerPoint presentation on Hunters Point for CWEA conference and for community public forum. | |
| Date of meeting: April 21 of 2004 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra.. |
| Meeting Summary: 1) preparation of PowerPoint presentation on Hunters Point for CWEA conference and for community public forum. | |
| Date of meeting: April 28 of 2004 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra.. |
| Meeting Summary: 1) PowerPoint presentation on Hunters Point at CWEA conference. | |
| Date of meeting: June 9 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) Review of community outreach information. | |
| Date of meeting: June 15 of 2004 | Individuals Present: Rhea L. Williamson and Wendy Jo Kroll. |
| Meeting Summary: 1) review of community outreach information; preparation of presentation materials and poster for the public meeting. | |
| Date of meeting: June 15 of 2004 | Individuals Present: Rhea L. Williamson, Wendy Jo Kroll, Rashmi Kashyap, and Divya Ramachandra.. |
| Meeting Summary: 1) review of final report needs, reference citations, information for the public forum. | |

**APPENDIX C**

**DOCUMENTS AND DATA REVIEWED FOR THE HUNTERS POINT STORM WATER WETLAND PROJECT**

## Documents and data reviewed for the Hunters Point Storm Water Wetland Project

| DATE | DESCRIPTION OF DOCUMENT/DATA |
|---|---|
| 03/18/03 | USEPA/ Region 9/ Superfund/ web-based document on the Hunters Point Naval shipyard including a site description, history, threats and contaminants, cleanup approach, environmental progress, responsible parties, documents and reports, repositories, contacts and other pertinent information. |
| 04/09/03 | http://www.efdsw.navfac.navy.mil/06/indexHP.htm. links to several other documents. |
| 04/10/03 | USEPA. 1999. Storm Water Technology Fact Sheet. Storm Water Wetlands. EPA 832-F-99-025. Office of Water. Washington D.C. |
| 04/17/03 | http://www.sfgov.org/site/sfra_page.asp?id=5588. Report from SF Redevelopment Agency. |
| 04/17/03 | http://www.hunterspointshipyard.com. |
| 04/28/03 | http://www.swrcb.ca.gov/rwqcb2/download/watershedmiipc.doc<br>San Francisco Bay Regional Water Quality Control Board:<br>Watershed Management Initiative Integrated Plan chapter |
| 04/28/03 | http://www.efdsw.navfac.navy.mil/06/HPS_E/Landfill_Gas/index.htm#weekly_activities<br>Parcel E: Landfill Gas Removal Action. Extraction Monitoring<br>Meteorological data |
| 04/28/03 | Historical Radiological Assessment Volume 2: Use of general radiological materials (634 pages) March 2002<br>http://www.efdsw.navfac.navy.mil/Environmental/pdf/HP/Draft_HRA.pdf |
| 04/28/03 | Historical Radiological Assessment Appendix B<br>http://www.efdsw.navfac.navy.mil/Environmental/Pages/hpHRA_appendixB.htm |
| 04/28/03 | http://www.efdsw.navfac.navy.mil/Environmental/HuntersPoint.htm. main page for several good links. Includes the Hunters Point Shipyard Environmental Cleanup Newsletter. Oct-Dec. 2001. Provides a chronological description of site activities. |
| 05/23/03 | Site Cleanup - Site Mitigation and Brownfields Reuse Program Database.<br>http://www.dtsc.ca.gov/database/Calsites/CALP001.CFM?IDNUM=38440005 . Retrieved on 5/24/03 |
| 05/23/03 | http://sfwater.org/detail.cfm/MSC_ID/73/MTO_ID/111/MC_ID/7/C_ID/1416/holdSession/1<br>---Photos and history of land use |
| 05/23/03 | Hunters Point Shipyard Decentralized Wastewater Treatment Study & Meetings 04- 07-2003.<br>http://sfwater.org/detail.cfm/MSC_ID/73/MTO_ID/111/MC_ID/7/C_ID/1416/holdSession/1 retrieved on 5/24/03 |
| 05/23/03 | http://www.fas.org/man/company/shipyard/hunters_point.htm<br>Military analysis network – has good figures of exact location on a map and also figures of each parcel along with the site numbers. |
| 05/23/03 | http://storm-water.com/Newsletters/1996/May96.PDF<br>--- storm water news letter (page 4) |
| 05/24/03 | http://www.dtsc.ca.gov/database/Calsites/Cortese_List.cfm?county=38 --- has good links which gives info about the list of actions taken in each parcel. |
| 05/24/03 | http://www.dtsc.ca.gov/database/Calsites/CALP001.CFM?IDNUM=38440005 -- detailed information on the actions taken on parcel E. |
| 05/26/03 | http://www.atsdr.cdc.gov/HAC/PHA/treasure/tre_toc.html<br>Gives very good information about the public health assessment with exposure dose and contaminants and lot more. |
| 06/09/03 | http://www.electmarie.freeservers.com/fire.html Lot of information about the contaminants in the soil, air. Links to several other related sites. Excellent recent photos of parcel E. |
| 06/09/03 | http://www.ujamaa.freeservers.com/MAP.HTM Earthquake amplification map |
| 06/09/03 | http://www.electmarie.freeservers.com/Arc_Ecology.htm Results of water, soil, and air samples |
| 06/12/03 | http://www.epa.gov/superfund/new/white.pdf Modeling to Evaluate Fate and Transport of Sediment-Bound Contaminants at Hunters Point shipyard |

**Documents and data reviewed for the Hunters Point Storm Water Wetland Project (continued)**

| DATE | DESCRIPTION OF DOCUMENT/DATA |
|---|---|
| 06/16/03 | http://www.swrcb.ca.gov/bptcp/docs/conplnv2.doc look at the ref (pg 119) |
| 06/18/03 | Reed, S., Crites, R. & Middlebrooks, E. (1995) Natural Systems for Waste Management and Treatment (2nd ed.). New York:McGraw-Hill. |
| 06/18/03 | Hammer, D. (1992). Creating Freshwater Wetlands. Michigan: Lewis Publishers. |
| 06/18/03 | Wetlands Engineering & River Restoration. (2001). ASCE Conference Proceedings. Software. |
| 06/18/03 | East Bay Regional Park District. (1983). Final Hayward Marsh Expansion Management Plan. Management Plan for second phase development of wetland adjacent to San Francisco Bay. |
| 06/23/03 | www.terraserver.microsoft.com topographical map access |
| 06/23/03 | http://quake.wr.usgs.gov/research/seismology/wg02/summary earthquake probability map for SF Bay area. |
| 06/23/03 | http://www.wrh.noaa.gov/Monterey/climate.html rainfall data (7 yrs for SF airport) |
| 06/23/03 | http://www.wrcc.dri.edu/summary/climsmsfo.html very good link for climate summary at various station points in SF Bay area. |
| 06/23/03 | http://www.wrcc.dri.edu/htmlfiles/westevap.final.html. good link for evaporation rate at various station points in SF Bay area. |
| 07/16/03 | http://www.atsdr.cdc.gov/HAC/PHA/treasure/tre_p2.html. lists stormwater contaminants of concern. |
| 07/16/03 | http://efdsw.navfac.navy.mil/06HPS-E/investigation/PDF/draft_landfill_gas_report.final V2.pdf. provides information on landfill gas, recommended clay liner (?). |
| 09/22/03 | U.S. Department of Navy responses to agency comments on the Draft Storm Water Discharge Management Plan IR-01/21, Industrial Landfill, Parcel E, Hunters Point Shipyard, San Francisco, California of January 07, 2003. AECRU Contract No. N68711-00-D-0005. Prepared for the U.S. Department of Navy. Prepared by Tetra Tech EM Inc. |
| 09/22/03 | Final Storm Water Discharge Management Plan IR-01/21, Industrial Landfill, Parcel E, Hunters Point Shipyard, San Francisco, California. June 12, 2003. AECRU Contract No. N68711-00-D-0005. Prepared for the U.S. Department of Navy. Prepared by Tetra Tech EM Inc. |
| 09/22/03 | Draft Parcel E Nonstandard Data Gaps Investigation: Wetlands Delineation and Functions and Values Assessment: Parcels B and E, Hunters Point Shipyard, San Francisco, California. June 12, 2003. AECRU Contract No. N68711-00-D-0005. Prepared for the U.S. Department of Navy. Prepared by Tetra Tech EM Inc. |
| 09/22/03 | U.S. EPA Constructed Wetlands for Wastewater Treatment and Wildlife Habitat: 17 Case Studies. EPA832-R-93-005. September, 1993. |
| 09/22/03 | Draft Parcel E Nonstandard Data Gaps Investigation: Landfill Lateral Extent Evaluation. Hunters Point Shipyard, San Francisco, California. June 12, 2003. AECRU Contract No. N68711-00-D-0005. Prepared for the U.S. Department of Navy. Prepared by Tetra Tech EM Inc. |
| 01/19/04 | Draft Community Relations Plan. Hunters Point Shipyard, San Francisco, California. June 6, 2003. Prepared for the U.S. Department of Navy. Prepared by Innovative Technical Solutions, Inc. |
| 01/19/04 | Final First Five Year Review of Remedial Actions Implemented at Hunters Point Shipyard, San Francisco, California. December 10, 2003. Prepared by the Department of Navy. |
| 02/15/04 | Draft Hunters Point Shipyard Parcel F Validation Study. April 25, 2002. Prepared by the Department of Navy. |
| 02/15/04 | Draft Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan). Basewide Groundwater Monitoring Program. Hunters Point Shipyard, San Francisco, California. December 18, 2003. Prepared for the U.S. Department of Navy. Prepared by Tetra Tech EM, Inc. |

## APPENDIX D

## LIST OF AGENCY CONTACTS MADE FOR THE HUNTERS POINT CONSTRUCTION STROM WATER WETLAND PROMECT

**List of agency contacts made for the Hunters Point Constructed Storm Water Wetland Project**

| Name/Agency | Phone/Email | Date/ (Initials) | Contact Summary |
|---|---|---|---|
| Tom Mumley /RWQCB-SFB | 510-622-2395 | 09/16/03 (WJK) | Referred to Andre Breaux at 510-622-2324. Left her a message. |
| Julie Menack /SWQCB | | 07/30/03 (RK) | Spoke to her about the HPS. Some important points noted were: 1) RI/FS for parcel E has not been done yet. Only the preliminary report is available, 2) Interim capping done on the landfill has not yet been approved, and 3) A complete study on soil quality has not been done yet. A report on soil quality is expected by the end of summer. |
| James Collins/ OEHHA | 510-622-3146 jcollins@oehha.ca.gov | 06/17/03 (RK) | Provided us with all the contact information we needed; sent mails to agencies to help us. |
| Kathy Camarda /USEPA | | 07/30/03 (RK) | Spoke to her about the availability of most recent files on HPS. Got a list of files about parcel E. A request for some of those files has been placed. No reply has been received yet. |
| Jackie Lane /USEPA | Lane.Jackie@epa.gov | 07/30/03 (RK) | Requested information about the community around HPS. Received some contact information and came to know more about the agencies involved with HPS. Received some useful web sites with very good information on HPS. |
| Keith Forman/ U.S. Navy | (619)532-0913 formanks@efdsw.navfac.navy.mil | 07/30/03 (RK) | Discussed some points about HPS; Has been in contact through e-mail and phone; Got information about a few files available at San Francisco repository; He has offered to come down and meet with us if necessary at the final stages of the project. |
| Chien Kao/DTSC | (510)540-822 CKao@dtsc.ca.gov | 07/30/03 (RK) | Has been in contact through e-mail and phone. Helped in understanding some points about HPS. |
| Jim Polisini/DTSC | Jpolisin@dtsc.ca.gov | 07/30/03 (RK) | Has been in contact through e-mail; asked us to get a copy of the Parcel F Validation study; draw your own conclusions regarding the isopleths of PCBs in sediment off the landfill in the South Basin; also said that there is a clear trend of decreasing PCB sediment concentration with increasing distance from the landfill. |

**List of agency contacts made for the Hunters Point Constructed Storm Water Wetland Project (continued)**

| Name/Agency | Phone/Email | Date/(Initials) | Contact Summary |
|---|---|---|---|
| Michael Work/ USEPA | (415)972-3024 work.michael@epa.gov | 07/30/03 (RK) | Has been in contact through e-mail and phone. Gave some pointers about looking for files; Offered to help in whatever way he can. |
| Kathy Camarda/ USEPA (Superfund Records Center) | (415) 536-2000 camarda.kathy@epa.gov | 07/30/03 (RK) | Spoke to her about the availability of most recent files on HPS. Got a list of files about parcel E. A request for some of those files has been placed. Copies of requested files were provided to us. |
| Julie Menack /SWQCB | (510)622-2401 jsm@rb2.swrcb.ca.gov | 07/15/03 10/17/03 11/03 (RK) | Requested an update about the background levels of COCs in soils at Hunters Point. RI/FS for parcel E has not been done yet. Only preliminary report is available; Interim capping done on the landfill has not yet been approved; No complete study on soil quality has been done yet. A report on soil quality is expected by the end of summer.<br>The only soil data available is for the shoreline characteristics; No report yet on soil quality. The one that was due by the end of summer has been delayed; Should look forward to the Technical Memorandum of soil quality which might be available by the end of October; RI report on HPS (1993) may contain some background characteristics; No soil test has been done after the RI report. |
| Karen Taberski /RWQCB | kmt@rb2.swrcb.ca.gov | 01/19/04 (RLW) | Requested for pointers, to find the storm water runoff quality for San Francisco region. |
| Tom Gallivan / Stevens Geomembrane | 800-621-2281 | 01/ 29/04 (DR) | Requested geomembrane samples. |
| Misty/ Water Saver | 303-289-1818 | 01/30/04 (DR) | Requested liner samples |
| Andre Breaux/ RWQCB-Oakland | | (WJK) | Sending information on wetland regulatory issues |
| Ginger Mitcham/ Gundle Lining Sys. | 800-435-2008 | 01/30/04 (DR) | Requested liner samples |

## APPENDIX E

## VALUES OF RUNOFF COEFFICIENT (C) FOR RATIONAL FORMULA

**Values of Runoff Coefficient (C) for Rational Formula**
**http://water.me.vccs.edu/courses/CIV246/table2.htm**

| Land Use | C | Land Use | C |
|---|---|---|---|
| Business:<br>Downtown areas<br>Neighborhood areas | 0.70 - 0.95<br>0.50 - 0.70 | Lawns:<br>Sandy soil, flat, 2%<br>Sandy soil, avg., 2-7%<br>Sandy soil, steep, 7%<br>Heavy soil, flat, 2%<br>Heavy soil, avg., 2-7%<br>Heavy soil, steep, 7% | 0.05 - 0.10<br>0.10 - 0.15<br>0.15 - 0.20<br>0.13 - 0.17<br>0.18 - 0.22<br>0.25 - 0.35 |
| Residential:<br>Single-family areas<br>Multi units, detached<br>Multi units, attached<br>Suburban | 0.30 - 0.50<br>0.40 - 0.60<br>0.60 - 0.75<br>0.25 - 0.40 | Agricultural land:<br>Bare packed soil<br>*Smooth<br>*Rough<br>Cultivated rows<br>*Heavy soil, no crop<br>*Heavy soil, with crop<br>*Sandy soil, no crop<br>*Sandy soil, with crop<br>Pasture<br>*Heavy soil<br>*Sandy soil<br>Woodlands | 0.30 - 0.60<br>0.20 - 0.50<br>0.30 - 0.60<br>0.20 - 0.50<br>0.20 - 0.40<br>0.10 - 0.25<br>0.15 - 0.45<br>0.05 - 0.25<br>0.05 - 0.25 |
| Industrial:<br>Light areas<br>Heavy areas | 0.50 - 0.80<br>0.60 - 0.90 | Streets:<br>Asphalt<br>Concrete<br>Brick | 0.70 - 0.95<br>0.80 - 0.95<br>0.70 - 0.85 |
| Parks, cemeteries | 0.10 - 0.25 | Unimproved areas | 0.10 - 0.30 |
| Playgrounds | 0.20 - 0.35 | Drives and walks | 0.75 - 0.85 |
| Railroad yard areas | 0.20 - 0.40 | Roofs | 0.75 - 0.95 |

***Note:** The designer must use judgment to select the appropriate "C" value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have the lowest "C" values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should assigned the highest "C" values.

# APPENDIX F

## WATER NEEDS FOR THE HUNTERS POINT STORM WATER WETLAND PROJECT

Water Needs for the Hunters Point Storm Water Wetland Project - Average Year

| Month | Precipitation[1] (in/mo) | Evaporation[2] (in/mo) | Inflow: Direct Precipitation[3] (acre-feet) | Inflow: Runoff[4] (acre-feet) | Outflow: Evaporation[3] (acre-feet) | Net Inflow (acre-feet) | Required Make-up Water (acre-feet) |
|---|---|---|---|---|---|---|---|
| January | 4.50 | 1.36 | 7.5 | 8.7 | -2.3 | 13.9 | 0.0 |
| February | 3.58 | 1.92 | 6.0 | 6.9 | -3.2 | 9.7 | 0.0 |
| March | 2.85 | 3.04 | 4.8 | 5.5 | -5.1 | 5.2 | 0.0 |
| April | 1.37 | 4.24 | 2.3 | 2.6 | -7.1 | -2.1 | 2.1 |
| May | 0.39 | 5.12 | 0.7 | 0.8 | -8.5 | -7.1 | 7.1 |
| June | 0.12 | 5.68 | 0.2 | 0.2 | -9.5 | -9.0 | 9.0 |
| July | 0.02 | 5.36 | 0.0 | 0.0 | -8.9 | -8.9 | 8.9 |
| August | 0.05 | 5.28 | 0.1 | 0.1 | -8.8 | -8.6 | 8.6 |
| September | 0.19 | 4.72 | 0.3 | 0.4 | -7.9 | -7.2 | 7.2 |
| October | 0.94 | 3.52 | 1.6 | 1.8 | -5.9 | -2.5 | 2.5 |
| November | 2.42 | 1.92 | 4.0 | 4.7 | -3.2 | 5.5 | 0.0 |
| December | 3.57 | 1.36 | 6.0 | 6.9 | -2.3 | 10.6 | 0.0 |
| **Total** | **20.00** | **43.52** | **33.3** | **38.6** | **-72.5** | **-0.6** | **45.5** |

Notes

[1]Values based on average of precipitation data for SFO from 1948-2003.
Website: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?casfoa+sfo

[2]Values based on 80 percent of pan evaporation data for SFO estimated from meteorological data using the Penman equation.
Website: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html

[3]Assumes 20 acres of wetland area.

[4]Assumes 38 acres of watershed area (excluding wetlands) with a composite runoff coefficient of 0.61.

**Water Needs for the Hunters Point Storm Water Wetland Project - Dry Year**

| | | | Inflow | | Outflow | | |
|---|---|---|---|---|---|---|---|
| Month | Precipitation[1] (in/mo) | Evaporation[2] (in/mo) | Direct Precipitation[3] (acre-feet) | Runoff[4] (acre-feet) | Evaporation[3] (acre-feet) | Net Inflow (acre-feet) | Required Make-up Water (acre-feet) |
| January | 2.36 | 1.36 | 3.9 | 4.6 | -2.3 | 6.2 | 0.0 |
| February | 1.88 | 1.92 | 3.1 | 3.6 | -3.2 | 3.6 | 0.0 |
| March | 1.49 | 3.04 | 2.5 | 2.9 | -5.1 | 0.3 | 0.0 |
| April | 0.72 | 4.24 | 1.2 | 1.4 | -7.1 | -4.5 | 4.5 |
| May | 0.20 | 5.12 | 0.3 | 0.4 | -8.5 | -7.8 | 7.8 |
| June | 0.06 | 5.68 | 0.1 | 0.1 | -9.5 | -9.3 | 9.3 |
| July | 0.01 | 5.36 | 0.0 | 0.0 | -8.9 | -8.9 | 8.9 |
| August | 0.03 | 5.28 | 0.1 | 0.1 | -8.8 | -8.7 | 8.7 |
| September | 0.10 | 4.72 | 0.2 | 0.2 | -7.9 | -7.5 | 7.5 |
| October | 0.49 | 3.52 | 0.8 | 0.9 | -5.9 | -4.1 | 4.1 |
| November | 1.27 | 1.92 | 2.1 | 2.5 | -3.2 | 1.4 | 0.0 |
| December | 1.87 | 1.36 | 3.1 | 3.6 | -2.3 | 4.5 | 0.0 |
| **Total** | **10.48** | **43.52** | **17.5** | **20.2** | **-72.5** | **-34.8** | **50.7** |

Notes

[1] 10th percentile of annual precipitation data set. This total is spread over the year based on the relative monthly precipitation for the average year (e.g., January has 22.5% of annual precipitation; February has 19.25% of annual precipitation, etc.).
Website: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?casfoa+sfo

[2] Values based on 80 percent of pan evaporation data for SFO estimated from meteorological data using the Penman equation.
Website: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html

[3] Assumes 20 acres of wetland area.

[4] Assumes 38 acres of watershed area (excluding wetlands) with a composite runoff coefficient of 0.61.

**Water Needs for the Hunters Point Storm Water Wetland Project - Wet Year**

| | | | Inflow | | Outflow | | |
|---|---|---|---|---|---|---|---|
| Month | Precipitation[1] (in/mo) | Evaporation[2] (in/mo) | Direct Precipitation[3] (acre-feet) | Runoff[4] (acre-feet) | Evaporation[3] (acre-feet) | Net Inflow (acre-feet) | Required Make-up Water (acre-feet) |
| January | 6.49 | 1.36 | 10.8 | 12.5 | -2.3 | 21.1 | 0.0 |
| February | 5.16 | 1.92 | 8.6 | 10.0 | -3.2 | 15.4 | 0.0 |
| March | 4.11 | 3.04 | 6.9 | 7.9 | -5.1 | 9.7 | 0.0 |
| April | 1.97 | 4.24 | 3.3 | 3.8 | -7.1 | 0.0 | 0.0 |
| May | 0.56 | 5.12 | 0.9 | 1.1 | -8.5 | -6.5 | 6.5 |
| June | 0.17 | 5.68 | 0.3 | 0.3 | -9.5 | -8.9 | 8.9 |
| July | 0.03 | 5.36 | 0.1 | 0.1 | -8.9 | -8.8 | 8.8 |
| August | 0.07 | 5.28 | 0.1 | 0.1 | -8.8 | -8.5 | 8.5 |
| September | 0.27 | 4.72 | 0.5 | 0.5 | -7.9 | -6.9 | 6.9 |
| October | 1.36 | 3.52 | 2.3 | 2.6 | -5.9 | -1.0 | 1.0 |
| November | 3.49 | 1.92 | 5.8 | 6.7 | -3.2 | 9.4 | 0.0 |
| December | 5.15 | 1.36 | 8.6 | 9.9 | -2.3 | 16.3 | 0.0 |
| **Total** | **28.83** | **43.52** | **48.1** | **55.7** | **-72.5** | **31.2** | **40.6** |

Notes

[1] 90th percentile of annual precipitation data set. This total is spread over the year based on the relative monthly precipitation for the average year (e.g., January has 22.5% of annual precipitation; February has 19.25% of annual precipitation, etc.).
Website: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?casfoa+sfo

[2] Values based on 80 percent of pan evaporation data for SFO estimated from meteorological data using the Penman equation.
Website: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html

[3] Assumes 20 acres of wetland area.

[4] Assumes 38 acres of watershed area (excluding wetlands) with a composite runoff coefficient of 0.61.

**APPENDIX G**

**ASSESSMENT OF WETLAND PLANTS OF THE SAN FRANCISCO BAY AREA IN RELATION TO ECOLOGICAL MOSQUITOE CONTROL**

**From Appendix I of Collins and Resh (1989)**

A practical assessment of common plants of palustrine wetlands of the San Francisco Bay Area in relation to ecological mosquito control.

Plant species in this appendix are classified by growth form, according to the scheme of the Tennessee Valley Authority (see list of information sources, p. 85). Each plant species is quantitatively evaluated on a scale of 1 to 5 with regard to each of the following four ecological parameters.

(1) Intersection Line Value (ILV). This value is high for plants with complex architecture that provide abundant positive menisci during most of the plant growth cycle; moderate for plants that usually provide intermediate amounts of positive menisci or that provide abundant menisci for a short portion of the plant growth cycle; low for plants that provide negative menisci or that have simple architecture that provides scarce positive menisci.

(2) Crayfish Food Value (CFV). This value is low for plants that are usually accessible and preferable as food for mature crayfish; moderate for plants that are seasonally not accessible or that are not preferred as food; high for plants that are not palatable or that are usually not accessible.

(3) Waterfowl Food Value (WFV). This value is low for plants that are entirely palatable and that are preferred as food by dabbling ducks and geese; moderate for plants that are palatable in part or that are not preferred as food; high for plants that are either not palatable or that do not usually occur where waterfowl are abundant.

(4) Fish Obstruction Value (FOV). This value is high for plants that provide abundant positive menisci and that restrict dispersal and predation by insectivorous fish at the water surface; moderate for plants that provide abundant menisci but that do not restrict fish dispersal; low for plants that neither provide abundant positive menisci nor restrict fish dispersal.

A plant complements ecological mosquito control with regard to any parameter for which the plant has a low score. The sum of scores for all four parameters for any plant is its total score. A low total score for a plant indicates that it complements ecological mosquito control in general. The following scale is a guideline to identify potentially beneficial or detrimental plants that are listed in the Appendix.

| Plant Assessment | Recommended Management Practice |
|---|---|
| Total Score < 9 | maintain natural patch size. |
| 9 < Total Score < 13 | maintain small patch size. |
| Total Score > 14 | minimize patch size. |

This practical assessment is based upon information from a variety of sources, including correspondence with personnel of the California Department of Fish and Game and the United States Fish and Wildlife Service (San Pablo Bay and San Francisco Bay National Wildlife Refuges).

| PLANT FORM | TAXA | ILV | CFV | WFV | FOV | Total |
|---|---|---|---|---|---|---|
| Erect-Naked | | | | | | |
| | Chenopodiaceae (pickleweeds) | | | | | |
| | *Salicornia virginica* | 2 | 5 | 5 | 1 | 13 |
| | Asteraceae (brass-button) | | | | | |
| | *Cotula coronopifolia* | 2 | 5 | 1 | 2 | 10 |
| | Juncaginaceae (arrowgrass) | | | | | |
| | *Triglochin maritima* | 1 | 5 | 4 | 1 | 11 |
| | Juncaceae (rushes) | | | | | |
| | *Juncus effusus* | 1 | 3 | 4 | 2 | 10 |
| | *J. patens* | 1 | 3 | 4 | 2 | 10 |
| | *J. balticus* | 1 | 3 | 4 | 2 | 10 |
| | *J. lesueurii* | 1 | 3 | 3 | 2 | 9 |
| | *J. acutus* | 1 | 3 | 5 | 4 | 13 |
| | *J. bufonius* | 1 | 3 | 3 | 2 | 9 |
| | *J. sphaerocarpus* | 1 | 3 | 4 | 2 | 10 |
| | *J. bolanderi* | 1 | 3 | 4 | 2 | 10 |
| | *J. rugulosus* | 1 | 3 | 4 | 2 | 10 |
| | *J. torreyi* | 1 | 3 | 4 | 2 | 10 |
| | *J. xiphioides* | 1 | 3 | 4 | 2 | 10 |
| | Cyperaceae (bullrushes, spikerushes, sedges) | | | | | |
| | *Scirpus fluviatilis* | 1 | 4 | 5 | 3 | 13 |
| | *S. robustus* | 1 | 4 | 2 | 2 | 9 |
| | *S. americanus* | 1 | 4 | 2 | 3 | 10 |
| | *S. olneyi* | 1 | 4 | 4 | 3 | 12 |
| | *S. acutus* | 1 | 5 | 5 | 4 | 15 |
| | *S. koilolepsis* | 1 | 3 | 2 | 3 | 9 |
| | *S. californicus* | 1 | 5 | 5 | 4 | 15 |
| | *Cyperus niger* | 1 | 4 | 4 | 3 | 12 |
| | *C. aristatus* | 1 | 3 | 2 | 3 | 9 |
| | *C. difformis* | 1 | 4 | 4 | 2 | 11 |
| | *C. esculentus* | 2 | 4 | 4 | 3 | 13 |
| | *Eleocharis palustris* | 1 | 3 | 4 | 2 | 10 |
| | *Carex stipata* | 2 | 4 | 4 | 3 | 13 |
| | *C. bolanderi* | 2 | 4 | 4 | 3 | 13 |
| | *C. obnupta* | 2 | 4 | 3 | 2 | 11 |
| | *C. rostrata* | 2 | 4 | 5 | 3 | 14 |
| | Sparganiaceae (burreeds) | | | | | |
| | *Sparganium eurycarpum* | 2 | 4 | 4 | 3 | 13 |
| | Typhaceae (cattails) | | | | | |
| | *Typha latifolia* | 2 | 5 | 5 | 5 | 17 |
| | *T. angustifolia* | 2 | 5 | 5 | 4 | 16 |
| | *T. glauca* | 2 | 5 | 5 | 4 | 16 |

| PLANT FORM | TAXA | ILV | CFV | WFV | FOV | Total |
|---|---|---|---|---|---|---|
| Erect-Leafy | | | | | | |
| | Equisetaceae (horsetails) | | | | | |
| | *Equisetum arvense* | 2 | 5 | 5 | 2 | 14 |
| | Pteridaceae (ferns) | | | | | |
| | *Pteridium aquilinum* | 2 | 5 | 5 | 1 | 13 |
| | Plantaginaceae (plantains) | | | | | |
| | *Plantago hirtella* | 2 | 3 | 3 | 1 | 9 |
| | *P. major* | 2 | 3 | 3 | 1 | 9 |
| | Alismataceae (water-plantains, arrowheads) | | | | | |
| | *Alisma triviale* | 2 | 2 | 2 | 1 | 7 |
| | *A. geyeri* | 2 | 2 | 2 | 1 | 7 |
| | *Sagittaria latifolia* | 2 | 2 | 2 | 1 | 7 |
| | *S. montevidensis* | 2 | 3 | 2 | 1 | 8 |
| | *S. longiloba* | 2 | 2 | 2 | 1 | 7 |
| | *S. sanfordii* | 2 | 2 | 2 | 1 | 7 |
| | *Echinodorus berteroi* | 2 | 4 | 2 | 2 | 10 |
| | Onagraceae (primroses) | | | | | |
| | *Ludwigia spp.* | 2 | 2 | 4 | 1 | 9 |
| | *Jussiaea repens* | 4 | 3 | 4 | 5 | 16 |
| | Lythraceae (loosestrifes) | | | | | |
| | *Lythrum californicum* | 2 | 4 | 4 | 3 | 13 |
| Flexus | | | | | | |
| | Frankeniaceae (alkali heath) | | | | | |
| | *Frankenia grandifolia* | 2 | 5 | 5 | 2 | 14 |
| | Poaceae (grasses) | | | | | |
| | *Phragmites communis* | 3 | 5 | 5 | 4 | 17 |
| | *Distichlis spicata* | 4 | 5 | 5 | 4 | 18 |
| | *Deschampsia danthonoides* | 3 | 5 | 2 | 1 | 11 |
| | *D. beringensis* | 3 | 5 | 2 | 1 | 11 |
| | *D. holciformis* | 3 | 5 | 2 | 1 | 11 |
| | *Alopecurus howellii* | 2 | 4 | 2 | 1 | 9 |
| | *Polypogon elongatus* | 2 | 4 | 4 | 1 | 11 |
| | *Echinochloa crusgalli* | 3 | 4 | 1 | 3 | 11 |
| | *Glyceria leptostachya* | 2 | 4 | 3 | 3 | 12 |
| | *G. occidentalis* | 2 | 4 | 3 | 3 | 12 |
| | *Zizania aquatica* | 3 | 2 | 4 | 4 | 13 |
| | *Leersia oryzoides* | 3 | 2 | 3 | 3 | 11 |
| | *Oryza sativa* | 2 | 2 | 2 | 3 | 9 |
| | *Phalaris arundinacea* | 3 | 4 | 4 | 3 | 14 |
| | *Beckmannia syzigachne* | 2 | 4 | 3 | 3 | 12 |
| | *Heleochloa schoenoides* | 2 | 4 | 1 | 3 | 10 |
| | *Leptochloa fascicularis* | 2 | 4 | 1 | 3 | 10 |

| PLANT FORM | TAXA | ILV | CFV | WFV | FOV | Total |
|---|---|---|---|---|---|---|
| Flexus (continued) | | | | | | |
| | Polygonaceae (smartweeds) | | | | | |
| | *Polygonum punctatum* | 3 | 4 | 2 | 3 | 12 |
| | *P. coccineum* | 3 | 4 | 2 | 3 | 12 |
| | *P. hydropiperoides* | 3 | 4 | 2 | 3 | 12 |
| | *P. lapathifolium* | 3 | 4 | 2 | 3 | 12 |
| | *P. paronychia* | 3 | 4 | 2 | 3 | 12 |
| | *P. patulum* | 3 | 4 | 2 | 3 | 12 |
| | *P. amphibium* | 4 | 4 | 1 | 5 | 14 |
| | *P. pennsylvanicum* | 3 | 4 | 2 | 3 | 12 |
| | Rosaceae (cinquefoils) | | | | | |
| | *Potentilla rivalis* | 3 | 3 | 2 | 3 | 11 |
| | *P. palustris* | 3 | 3 | 2 | 3 | 11 |
| | Asteraceae (cocklebures) | | | | | |
| | *Xanthium strumarium* | 2 | 4 | 5 | 3 | 14 |
| Pleuston | | | | | | |
| | Lemnaceae (duckweeds) | | | | | |
| | *Spirodela polyrhiza* | 1 | 5 | 2 | 1 | 9 |
| | *Lemna minima* | 1 | 5 | 2 | 1 | 9 |
| | *L. perpusilla* | 1 | 5 | 2 | 1 | 9 |
| | *L. gibba* | 1 | 5 | 2 | 1 | 9 |
| | *L. valdiviana* | 1 | 5 | 2 | 1 | 9 |
| | *Wolffiella lingulata* | 1 | 5 | 2 | 1 | 9 |
| | Salviniaceae (water ferns) | | | | | |
| | *Azolla filiculoides* | 1 | 4 | 4 | 1 | 10 |
| Floating Mat | | | | | | |
| | Apiaceae (marsh pennyworts) | | | | | |
| | *Hydrocotyle ranunculoides* | 4 | 4 | 2 | 5 | 15 |
| | *H. umbellata* | 4 | 4 | 2 | 5 | 15 |
| | Ranunculaceae (crowfoots) | | | | | |
| | *Caltha howellii* | 4 | 4 | 3 | 4 | 15 |
| | *Ranunculus flammula* | 4 | 4 | 3 | 4 | 15 |
| | *R. pusillus* | 4 | 4 | 3 | 4 | 15 |
| | *R. flabellaris* | 4 | 4 | 3 | 4 | 15 |
| | *R. aquatilis* | 4 | 4 | 3 | 5 | 16 |
| | Brassicaceae (water-cress) | | | | | |
| | *Nasturtium officinale* | 4 | 4 | 2 | 5 | 15 |
| | Scrophulariaceae (figworts) | | | | | |
| | *Bacopa nobsiana* | 3 | 4 | 3 | 3 | 13 |

| PLANT FORM | TAXA | ILV | CFV | WFV | FOV | Total |
|---|---|---|---|---|---|---|
| Floating Leaf | | | | | | |
| | Nymphaeaceae (cow-lily, water-shield) | | | | | |
| | *Nuphar polysepalum* | 3 | 2 | 4 | 2 | 11 |
| | *Brasenia schreberi* | 1 | 4 | 5 | 2 | 12 |
| | Araceae (water-lettuce) | | | | | |
| | *Pistia stratiotes* | 4 | 5 | 5 | 4 | 18 |
| | Pontederiaceae (water-hyacinth) | | | | | |
| | *Eichhornia crassipes* | 4 | 5 | 5 | 4 | 18 |
| | Potamogetonaceae (pondweeds) | | | | | |
| | *Potamogeton crispus* | 2 | 2 | 2 | 2 | 8 |
| | *P. diversifolius* | 2 | 2 | 2 | 2 | 8 |
| | *P. nodosus* | 2 | 2 | 2 | 2 | 8 |
| Submergent | | | | | | |
| | Haloragaceae (water-milfoils) | | | | | |
| | *Myriophyllum brasiliense* | 5 | 3 | 4 | 5 | 17 |
| | *M. spicatum* | 4 | 2 | 4 | 4 | 14 |
| | Callitrichaceae (water-starwort) | | | | | |
| | *Callitriche longipedunculata* | 2 | 2 | 4 | 3 | 11 |
| | Zannichelliaceae (horned pondweeds) | | | | | |
| | *Zannichellia palustris* | 2 | 2 | 4 | 2 | 10 |
| | Najadaceae (water-nymphs) | | | | | |
| | *Najas flexilis* | 3 | 2 | 4 | 2 | 11 |
| | *N. graminea* | 3 | 2 | 4 | 2 | 11 |
| | Lentibulariaceae (bladderworts) | | | | | |
| | *Utricularia vulgaris* | 3 | 3 | 4 | 3 | 13 |
| | *U. gibba* | 3 | 3 | 4 | 2 | 12 |
| | Ceratophyllaceae (hornworts) | | | | | |
| | *Ceratophyllum demersum* | 3 | 4 | 4 | 4 | 15 |
| | Hydrocharitaceae (frogbits) | | | | | |
| | *Elodea densa* | 3 | 2 | 4 | 2 | 11 |
| | *E. canadensis* | 1 | 2 | 4 | 1 | 8 |
| | Ruppiaceae (wigeon grass) | | | | | |
| | *Ruppia spiralis* | 3 | 3 | 2 | 3 | 11 |
| | Potamogetonaceae (pondweeds) | | | | | |
| | *Potamogeton filiformis* | 4 | 2 | 3 | 4 | 13 |
| | *P. pectinatus* | 5 | 2 | 1 | 5 | 13 |
| | *P. foliosus* | 4 | 2 | 3 | 4 | 13 |

APPENDIX H

LINER TYPES, PROPERTIES, APPLICATIONS, AND MANUFACTURERS AVAILABLE FOR HUNTERS POINT STORM WATER WETLAND

**Liner Types, Properties, Application, and Manufacturers Available for Hunters Point Storm Water Wetland**

USEPA guidelines on "Liners and Leak Detection Systems for Hazardous Waste Land Disposal Units" are available at http://tis.eh.doe.gov/oepa/guidance/rcra/leak.pdf.

There are different types of liners based on the properties of a liner and the application for use (Table H-1). For a wetland with a double liner and a leak detection system, components to consider include:
liner for water impoundment
liner chemically resistant to hazardous material
textile for drainage collection
sealant

**Table H-1. Liner Types, Properties, Application, and Manufacturers.**

| Application | Properties | Product name | Manufacturer |
|---|---|---|---|
| Water impoundments | Low thermal expansion/contracting properties;<br>Tough | 8130 XR-5,<br>8138 XR-5,<br>8228 XR-3,<br>XR-3 FILM<br>8130 XR-3 PW | XR Technology |
| Resistant to Hazardous Waste | Resistant to various strong chemicals, acids, oxidizing agents, oil, some nuclear wastes and others.<br>Resistant to cracking<br>Very low permeability | Polypropylene geomembrane<br>Hyplon geomembrane<br>XR-5 Geomembrane Liner<br>RUFCO 3000B<br>Coolshield<br>Coolthane | Cooley, Stevens Geomembranes<br>Stevens Geomembranes<br>Geomembrane<br><br>Bristar Containment Industries Inc.<br>Cooley |
| Component of landfill base seals | Containment of contaminated liquid | Carbofol | Naue Fasertechnik GmbH & Co. |
| Drainage | Retains soil, allows root growth | Terrafix® | Naue Fasertechnik GmbH & Co. |

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## Letter 82: Arc Ecology (1/12/10)

### *Response to Comment 82-1*

This comment contains introductory, closing, or general background information and is not a direct comment on environmental issues or the content or adequacy of the Draft EIR. No response is required.

### *Response to Comment 82-2*

As a result of the size of the Project, the mass emissions will be above the BAAQMD mass emission thresholds of significance (Impact AQ-4), resulting in a "significant and unavoidable" determination. However, despite its size, the Project has been designed to minimize these exceedances to the extent possible. The Project's design incorporates a dense, compact development plan that includes a diverse mix of land uses that are well connected with regional mass transit systems, all of which serve to reduce the mass emissions of this Project compared to a similar sized project without these design features, as stated on page III.H-31:

> Table III.H-5 (Operational Criteria Pollutant Emissions [Year 2030]) presents the emission modeling with comparisons to BAAQMD thresholds and the transportation scenario without trip reduction features (referred to as the Business as Usual [BAU] scenario). The estimated daily criteria pollutant emissions associated with the proposed Project and the BAU scenario are shown in Table III.H-5 in comparison with each other and with the BAAQMD CEQA significance criteria. Although the Project would generate substantially fewer emissions than the BAU scenario (i.e., from 14 to 50 percent less than BAU depending on the pollutant), Project emissions of ROG, $NO_X$, $PM_{10}$, and $PM_{2.5}$ would exceed the BAAQMD thresholds. No additional feasible mitigation measures have been identified that would further reduce the Project's operational criteria emissions below the BAAQMD thresholds. This would be a significant and unavoidable impact.
>
> However, the Project design is a dense, infill mixed-use project, with a transit-oriented design, which is consistent with Senate Bill 375 as well as the San Francisco's sustainable city initiatives to reduce emissions, on a per-capita basis by its very nature. However, the BAAQMD CEQA guidelines list a total mass of criteria pollutants as its CEQA threshold. Accordingly, a large project, such as this one, regardless of its design and location will always exceed these mass-based thresholds.

While the emissions from the Project may exceed the mass thresholds, as discussed in Impact AQ-9, the Project would conform to the current regional air quality plan, and therefore would not impair the ability of the BAAQMD to maintain air quality within its jurisdiction. Therefore, the Project would neither worsen existing air quality nor contribute substantially to projected air quality violations.

### *Response to Comment 82-3*

The comment incorrectly states that requiring a site mitigation plan, contingency plan, or health and safety plan does not constitute a mitigation measure, but only "a promise of the intent to have a mitigation measure." In fact, the Draft EIR provides legally binding mitigation through formulation of, and compliance with, approved plans meeting certain performance standards and utilizing detailed methods.

As the Draft EIR explains, the Project is legally committed to utilizing the mitigation measures corresponding to Impacts HZ-1 through HZ-14. Prior to obtaining a site permit, building permit or other authorization from the City for development activities in various areas, the Project Applicant must comply with the mitigation measures, which require, for example, preparation of a site mitigation plan under Article 22A of the *San Francisco Health Code* (MM HZ-1a), or approval by the San Francisco Department of Public Heath of an unknown contaminants contingency plan (MM HZ-2a.1). Without such approval and compliance with the mitigation measures, no permit may be issued, and no development may take place.

The mitigation measures do not, and cannot, contain the full specifics of the site mitigation plans, contingency plans, and health and safety plans since those plans must take into account circumstances that exist at the time they are prepared. However, the Draft EIR does provide significant detail about the purposes and required content of the plans and the standards they must be designed to achieve. For example, mitigation measure MM HZ-1a, Draft EIR page III.K-54, requires that, where the site investigation reveals a hazardous materials release:

> The site mitigation plan shall identify, as appropriate, such measures as excavation, containment, or treatment of the hazardous materials, monitoring and follow-up testing, and procedures for safe handling and transportation of the excavated materials, or for protecting the integrity of the cover or for addressing emissions from remedial activities, consistent with the requirements set forth in Article 22A.

The Draft EIR further states that any remedial activities, safety protocols, and control measures required would be similar to the specific measures described in Draft EIR Table III.K-2 (Remedial Actions, Potential Environmental Effects, and Methods to Reduce Effects), pages III.K-74 -76. Similarly, mitigation measure MM HZ-2a.1, in describing contingency plans, states the plans will accomplish appropriate notification and site control utilizing methods including further investigation and remediation in various forms where necessary. Please refer to the mitigation measures corresponding to Impacts HZ-1 through HZ-14 for further detail.

## Response to Comment 82-4

Mitigation measure MM HZ-10b provides for the creation of legally binding design documents, approved by all required regulatory agencies (including US EPA, DTSC, RWQCB, and the Navy and CDPH if necessary) for the installation of any pilings through a landfill cap. The Draft EIR outlines specific standards those documents must adhere to; in particular, they must describe how the cap will be evaluated to determine the potential adverse affect of shoreline improvements, and they must describe the method of construction to mitigate environmental risk and restore the cap. Mitigation measure MM HZ-10b ensures that, before any construction activities take place that could potentially affect contaminated sediments, the Agency, its contractors, or the Project Applicant shall comply with all requirements incorporated into the design documents, work plans, health and safety plans, dust control plans, and any other document or plan required under the Administrative Order on Consent. In addition to Impact HZ-10 and mitigation measure MM HZ-10b, refer to Master Response 10 (Pile Driving through Contaminated Soil) for a detailed discussion on these topics.

## Response to Comment 82-5

As stated in mitigation measure MM HZ-15, Draft EIR page III.K-99, the Project Applicant must attain approval of an Asbestos Dust Mitigation Plan (ADMP) prior to obtaining any permit from the City that includes soil disturbing activities for areas over one acre, and additionally the Project Applicant must attain approval of a Dust Control Plan (DCP) prior to obtaining any such permit for areas over 0.5 acre. The ADMP and DCP must be approved by BAAQMD and SFDPH, respectively, and must meet certain standards through numerous dust control measures. The DCP addresses all forms of dust and is not specifically targeted at naturally occurring asbestos, although most of the mitigation measures required by the plan have the effect of controlling emissions of naturally occurring asbestos disturbed during excavation activities. The City and County of San Francisco's "no visible dust" objective is likewise not specifically targeted at naturally occurring asbestos emissions. The ADMP approved by the BAAQMD is specifically targeted at controlling naturally occurring asbestos emissions (whether visible or not), as required by the state regulation promulgated by the California Air Resources Board called the Airborne Toxic Control Measures (ATCM). The state ATCM regulations do not require ambient air monitoring to be included as a part of ADMPs; however, the regulations provide that air districts may require an ADMP to include such monitoring. Consistent with the state ATCM regulations, MM HZ-15 requires the ADMP for the Project to include ambient monitoring to the extent the BAAQMD requires such monitoring. In approving the ADMP for HPS Phase I, the BAAQMD did require ambient air monitoring, and continues to require it. There is no reason to believe the BAAQMD would vary from its position of requiring ambient air monitoring when approving the ADMP for the Project. Refer to mitigation measure MM HZ-15 and Master Response 12 (Naturally Occurring Asbestos) for detail regarding the DCP and ADMP.

## *Response to Comment 82-6*

Comment noted. The shutdown criteria in the BAAQMD-approved ADMP for HPS Phase I was established using the methodology employed by the California Office of Environmental Health Hazard Assessment (OEHHA), and corresponds to a risk level of one increased cancer per 10,000 (at the level suggested by the commenter). As indicated in the Response to Comment 82-5, there is no reason to believe the BAAQMD will require a different monitoring program in the ADMP for the Project than it did for the ADMP for HPS Phase I.

## *Response to Comment 82-7*

The ambient air monitoring conducted by the Project Applicant at HPS Phase I includes four "community" monitoring stations operated by an independent contractor under the supervision of the San Francisco Department of Public Health. Samples from these monitoring stations are analyzed by a different laboratory than the one that analyzes the samples from the monitors operated under the direct supervision of the Project Applicant. Under the ADMP, the results of the community air monitors have the same legal effect as those of the monitors operated under the direct supervision of the Project Applicant; in both cases the Project Applicant is required to shut down project operations if monitoring results are above certain thresholds. If the BAAQMD requires ambient air monitoring to be included in the ADMP for the Project (as described in the Response to Comment 82-5 above), it is likely that similar community monitoring stations will be utilized. With respect to the public provision of monitoring data, monitoring results will be available to the community through Navy and City community participation programs and through regulatory agencies. Further, additional notice requirements will be implemented under mitigation measure MM HZ-15, Draft EIR page III.K-99, as described in Master Response 16 (Notification Regarding Environmental Restrictions and Other Cleanup Issues).

The shutdown criteria in the BAAQMD-approved ADMP for HPS Phase I is if the results from one of the air monitors exceeds 16,000 structures per cubic meter. This level was established using the methodology employed by the California Office of Environmental Health Hazard Assessment (OEHHA), and corresponds to a risk level of one increased cancer per 10,000 (at the level suggested by the commenter). As indicated in Response to Comment 82-5, there is no reason to believe the BAQMD will require a different monitoring program in the ADMP for the Project than it did for the ADMP for HPS Phase I.

### *Response to Comment 82-8*

The commenter states that removal of riprap at Candlestick Point would have a significant impact on oysters and recommends replacement of hard substrate that is to be removed with new hard substrate. As stated in Impact BI-10a, page III.N-83 in the Draft EIR, the scenario recommended by the commenter is what is anticipated to occur as a result of the Project—hard substrate that is removed will be replaced by similar hard substrate suitable for colonization by oysters. Thus, the Draft EIR correctly concludes that impacts to oysters on Candlestick Point will be less than significant.

### *Response to Comment 82-9*

The commenter states that the mitigation measures for potential Project impacts to green sturgeon are incomplete, as Section 7 consultation with the NMFS will be necessary regarding impacts to this species. The commenter suggests that the NMFS may not approve impacts from the bridge.

The regulatory process, which may include a Section 7 consultation, is a parallel but separate process from the CEQA process, and resolution of permitting issues is not required for assessment of impacts, specification of measures necessary to mitigate impacts to less than significant levels, and project approval under CEQA.

### *Response to Comment 82-10*

In reference to the comment that re-suspension of sediment at Candlestick Point may result in impacts to biological resources, Impact BI-19a referenced in this comment pertains to the operational aspects of the development at Candlestick Point. No activities resulting in the re-suspension of sediments at Candlestick Point will occur after construction is completed.

### *Response to Comment 82-11*

In reference to the comment that consultation with the NMFS and CDFG will be necessary regarding potential maintenance dredging impacts to fish and eelgrass, refer to Response to Comment 82-9 above regarding the distinction between the regulatory permitting process and the CEQA process. The applicant will be required to consult with both agencies regarding regulatory issues, separate from the CEQA process.

## Response to Comment 82-12

One comment suggested that flashing lights, rather than continuously burning lights, on tops of buildings may not be permissible by the US Coast Guard. According to David Sulouff, Chief of the Bridge Section for the Eleventh Coast Guard District, the Coast Guard is not expected to have any concerns over lighting on tops of the towers on Candlestick Point and HPS Phase II, as such lights would not pose an impediment to navigation of vessels on San Francisco Bay.[121]

## Response to Comment 82-13

The suggestion that measures to protect native oysters from maintenance dredging, including a turbidity plume study, are not necessary, are noted. The commenter may be correct in suggesting that a survey for oysters on substrates within the marina may not detect the species. Nevertheless, in light of concerns regarding the status of this native species inside San Francisco Bay, these measures are being required to ensure against impacts to a substantial and important occurrence of the species (e.g., a large oyster bed), in the unlikely event that such an occurrence be present.

## Response to Comment 82-14

In reference to the comment regarding the Pacific herring spawning season and seasonal restrictions pertaining to the spawning season, refer to Response to Comment 37-1.

## Response to Comment 82-15

In response to the comment, the text in mitigation measure MM HZ-1a, Draft EIR page III.K-55 (and Table ES-2, page ES-51), has been revised as follows:

*MM HZ-1a* …

*To the extent that Article 22A does not apply to state-owned land at CPSRA, prior to undertaking subsurface disturbance activities at CPSRA, the Agency and the California Department of Parks and Recreation shall enter into an agreement to follow procedures ~~comparable~~ <u>equivalent</u> to those set forth in Article 22A for construction and development activities conducted at Candlestick Point State Recreation Area.*

## Response to Comment 82-16

Documents prepared for the Project approval hearing process will include a Mitigation Monitoring and Reporting Program, which will describe who is responsible for implementing and monitoring the mitigation measures that are adopted.

## Response to Comment 82-17

In response to the comment, mitigation measure MM HY-1a.1, Draft EIR page III.M-59 (and Table ES-2, page ES-77), has been edited to add the following text to the second item under the first bullet:

*MM HY-1a.1* […]

---

121 David H. Sulouff, pers. comm. to Steve Rottenborn of H. T. Harvey & Associates, March 10, 2010.

> *Erosion Control BMPs—Preserve existing vegetation where feasible, apply mulch or hydroseed areas with native, non-invasive species, until permanent stabilization is established, and use soil binders, geotextiles and mats, earth dikes and drainage swales, velocity dissipation devices, slope drains, or polyacrylamide to protect soil from erosion.*

In response to the comment, the text for mitigation measure MM HY-1a.2, Draft EIR page III.M-62 (and Table ES-2, pages ES-79 and -81), the following sentence has been added to the second item under the first bullet as well as to the first item under the tenth bullet:

*MM HY-1a.2* …

- *Erosion and Sedimentation:*

  …

  > *Stabilize and re-vegetate disturbed areas as soon as possible after construction with planting, seeding, and/or mulch (e.g., straw or hay, erosion control blankets, hydromulch, or other similar material) except in actively cultivated areas. Planting and seeding shall use native, non-invasive species.*

  …

- *Post-construction BMPs:*

  > *Re-vegetate all temporarily disturbed areas as required after construction activities are completed. Re-vegetation shall use native, non-invasive species.*

  …

In addition, Appendix N3 of the Draft EIR includes a Draft Parks, Open Space, and Habitat Concept Plan that describes proposed removal of, monitoring for, and ongoing control of invasive plants and describes proposed revegetation efforts.

## *Response to Comment 82-18*

Natural, living shorelines will be incorporated wherever possible and feasible with input from local agencies and stakeholders. Mitigation measures proposed will also require approvals from a myriad of environmental and other regulatory agencies prior to construction, which will provide independent review of their design and performance.

The design of the Project shoreline improvements must consider structural integrity, functionality, and regulatory requirements. Living shorelines emphasize the use of natural materials including marsh plantings, shrubs and trees, low profile breakwaters, strategically placed organic material, and other techniques that recreate the natural functions of a shoreline ecosystem. Table II-13 (Summary of Shoreline Improvements at the Project Site) of the Draft EIR, starting on page II-57, and Table II-14 (Description of Existing Shoreline Conditions and Proposed Improvement Concepts), starting on page II-59, shows the areas where beaches and tidal wetlands would be constructed. Table II-14 also identifies areas where bulkheads could be replaced with a natural shoreline edge. Figure II-20 (Natural Shoreline Recommended Work Map), on page II-68 of the Draft EIR, illustrates the areas where living shoreline elements are proposed.

In response to the comment, mitigation measure MM HY-12a.2, Draft EIR page III.M-102 (and Table ES-2, page ES-89), has been revised as follows:

> *MM HY-12a.2* Shoreline Improvements for Future Sea-Level Rise. *Shoreline and public access improvements shall be designed to allow future increases in elevation along the shoreline edge to keep up with higher sea level rise values, should they occur. Design elements shall include providing adequate setbacks to allow for future elevation increases of at least 3 feet ~~along the shoreline~~ from the existing elevation along the shoreline. Before the first Small Lot Final Map is approved, the Project Applicant must petition the appropriate governing body to form (or annex into if appropriate) and administer a special assessment district or other funding mechanism to finance and construct future improvements necessary to ensure that the shoreline, public facilities, and public access improvements will be protected should sea level rise exceed 16 inches at the perimeter of the Project. Prior to the sale of the first residential unit within the Project, the legislative body shall have acted upon the petition to include the property within the district boundary. The newly formed district shall also administer a Monitoring and Adaptive Management Plan to monitor sea level and implement and maintain the protective improvements*.

In response to the comment, the text for mitigation measure MM HY-14 on page III.M-106 (and Table ES-2, pages ES-90 to -91) of the Draft EIR has been revised as follows:

> *MM HY-14* Shoreline Improvements to Reduce Flood Risk. *To reduce the flood impacts of failure of existing shoreline ~~protection~~ structures, the Project Applicant shall implement shoreline improvements for flood control protection, as identified in the Candlestick Point/Hunters Point Development Project Proposed Shoreline Improvements report. Where feasible, elements of living shorelines shall be incorporated into the shoreline protection improvement measures.*

## Response to Comment 82-19

Refer to Master Response 8 (Sea Level Rise) and Responses to Comments 36-2, 57-1, and 58-3 for a comprehensive discussion of the sea level rise documents reviewed, the levels of sea level rise taken into account for various Project components, and the plan to provide flood protection if higher levels of sea level rise occur. The Adaptation Strategy includes measures to provide continued flood protection beyond the 16 inches of sea level rise that it is initially built to, thereby ensuring that open-space and public uses continue.

## Response to Comment 82-20

Refer to Response to Comment 82-16, which is identical to this comment.

## Response to Comment 82-21

Refer to Response to Comment 82-18 for a discussion of the incorporation of natural, living shoreline elements into the project, wherever possible and feasible, with input from local agencies and stakeholders, and to the extent that such measures are compatible with proposed shoreline treatments.

## Response to Comment 82-22

The suggestion that the natural shoreline incorporate a variety of habitats, including deep intertidal, eelgrass, and native oyster beds and reefs, is noted. The Project will incorporate habitat diversity into this shoreline to the extent that such measures are compatible with proposed shoreline treatments.

Refer also to Response to Comment 57-3 for a discussion of shoreline protection and improvements.

### *Response to Comment 82-23*

This comment contains introductory, closing, or general background information and is not a direct comment on environmental issues or the content or adequacy of the Draft EIR. No response is required.

### *Response to Comment 82-24*

Figure C&R-17 (Cross-section of the Yosemite Slough Bridge, With Stadium and Without Stadium) presents the proposed cross-section of the Yosemite Slough bridge under conditions with and without a new NFL stadium. As shown, with the stadium, the bridge would be 81 feet wide, including a 40-foot-wide bicycle/pedestrian promenade (which would be converted to four 10-foot-wide travel lanes on game days only), a 2-foot-wide median on either side of the promenade, two 11-foot-wide BRT lanes, a 2-foot-wide median barrier, a 12-foot-wide Class I bicycle/pedestrian facility, and a 1-foot-wide shoulder. Under conditions without the new stadium, the bridge would be 41 feet wide and would include a 12-foot-wide Class I bicycle/pedestrian facility and two 11-foot-wide BRT lanes.

### *Response to Comment 82-25*

This comment repeats information presented in the Draft EIR regarding traffic impacts of Alternative 2. No additional response is required.

### *Response to Comment 82-26*

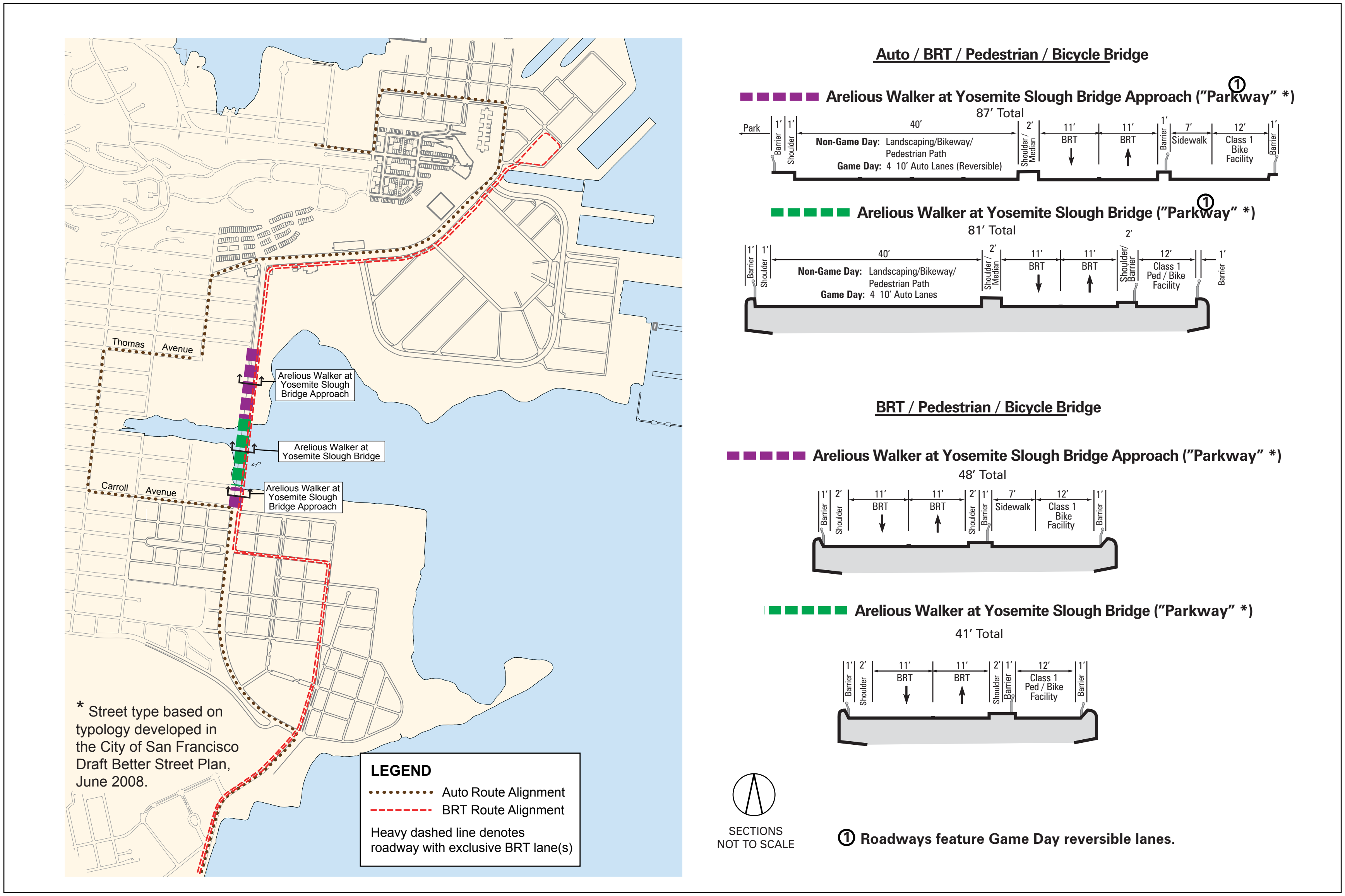
The intent of the statement was to note that game-day traffic impacts would be exacerbated under Alternative 2 without the bridge compared to the Project. In response to the comment, the text in Section VI.D (Environmentally Superior Alternative), second paragraph, second and third sentences, page VI-160, has been revised as follows:

> … Alternative 2 (CP-HPS Phase II Development Project, HPS Phase II Stadium, State Parks Agreement, and without the Yosemite Slough Bridge) would avoid Project impacts related to biological resources, water quality, and hazardous materials because the Yosemite Slough <u>bridge</u> would not be constructed. However, because the Yosemite Slough bridge would not be constructed, Alternative 2 would result in increased traffic-related impacts~~, particularly~~ on game days. …

### *Response to Comment 82-27*

In response to the comment, Figure VI-1 (Alternative 2 Circulation Plan Railroad Right-of-Way for Bus Rapid Transit) shows the correct alignment of the proposed BRT route for Alternative 2.

The commenter notes that the BRT route proposed under conditions without the Yosemite Slough bridge would travel in exclusive right-of-way and that the explanatory text does not include this information. In response to the comment, the text in Section VI.C (Analysis of Project Alternatives), under the Transit Impacts heading, page VI-34, the second paragraph under this heading, has been revised as follows:




SOURCE: Fehr & Peers; AECOM, 2010.

PBS&J 04.16.10 02056 | JCS | 10

**FIGURE C&R-17**

Candlestick Point — Hunters Point Shipyard Phase II EIR

**CROSS-SECTION OF THE YOSEMITE SLOUGH BRIDGE WITH STADIUM AND WITHOUT STADIUM**


Existing RR ROW

BRT Path: Using RR ROW for portion of route around Slough

Auto Route Alignment

0 500
Feet

SOURCE: SFMTA, 2010.

PBS&J 04.09.10 02056 | JCS | 10

**FIGURE VI-1**

Candlestick Point — Hunters Point Shipyard Phase II EIR

**ALTERNATIVE 2 CIRCULATION PLAN RAILROAD RIGHT-OF-WAY FOR BUS RAPID TRANSIT [REVISED]**

> Although the alternative BRT route around Yosemite Slough would be technically feasible, it would not be an optimal configuration for a BRT system. BRT service would provide direct, fast, and reliable travel in a dedicated right-of-way, typically with signal priority for ~~V~~BRT vehicles. When these elements are combined, the BRT service takes on a higher quality character than typical local bus service. The Yosemite ~~s~~Slough bridge would provide a dedicated right-of-way and the most direct route between Hunters Point Shipyard and points to the west, including Candlestick ~~p~~Point, the Bayshore Caltrain Station, and Balboa Park BART. Although the route around Yosemite Slough proposed under Alternative 2 would provide exclusive right-of-way, the route would involve a number of right-angle turns and additional signalized intersections and would not ~~accommodate the BRT route~~ provide a comparably direct route as that provided on the bridge proposed ~~with~~ by the Project.

## *Response to Comment 82-28*

Although the portion of the route around Yosemite Slough that travels within the Navy rail right-of-way would be "rail-ready," the primary area of concern with respect to rail-readiness of that route is the multiple right-angle turns and additional signalized intersections that the BRT would have to travel through between Arelious Walker Drive and the Navy rail right-of-way (i.e., along Carroll Avenue, Hawes Street, Armstrong Avenue and Shafter Avenue). Also refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge).

## *Response to Comment 82-29*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge), which describes how the route around the Yosemite Slough would be much less direct than the proposed bridge due to multiple right-angle turns and additional signalized intersections.

## *Response to Comment 82-30*

The estimate of travel time around Yosemite Slough was developed based on data regarding average vehicle travel speeds provided by SFMTA's cost estimation model, which was developed as part of the Transit Effectiveness Project. That data notes that local bus service travels an average speed of 7 miles per hour (mph), while BRT service typically travels at 10 mph. Although the route around the slough would provide exclusive right-of-way, due to the large number of right-angle turns through signalized intersections, the analysis assumes that the BRT would operate at speeds more similar to local bus service through this portion (i.e., 7 mph). The route across the bridge would operate more similar to typical BRT speeds (i.e., 10 mph) because it would have no intersections, no turns, and no conflicting bicycle, pedestrian, or traffic streams. Because it would not have to stop on the route across Yosemite Slough bridge, the average travel speed may, in fact, be higher than 10 mph.

The distance across the Yosemite Slough bridge (from Carroll Avenue to Shafter Avenue) is approximately 0.4 mile. The distance on the route around the slough is approximately 1 mile, a difference of 0.6 mile, and includes crossing through 12 to 14 intersections and four additional right turns that the route over the Yosemite Slough bridge would not require. The travel time for the BRT route across this distance (assuming an average 10 to 20 mph travel speed) would be approximately 1.25 to 2.5 minutes. The travel time for the BRT route around the slough (assuming an average 7 mph travel speed) would be 8.7 minutes, an increase of over 6 to 7.5 minutes. Therefore, the assumption of a 5-minute difference in travel time as disclosed in the Draft EIR is a reasonable estimate given the uncertainties in estimating actual transit travel time. As described above, the travel times used in the Draft EIR are from the same start and end points for both routes, so the comparison is valid. Although the route around the slough would provide exclusive right-of-way, its benefits would be limited because of the large number of right-angle turns through signalized intersections.

As noted above, an average travel speed of 7.3 mph is consistent with SFMTA's data regarding typical local bus speeds. Although the average speeds from SFMTA include dwell times at stops, they also are collected on routes traveling along typically straight corridors. The BRT route around Yosemite Slough would not have stops for passenger loading, but it would have more sharp turns through signalized intersections, which are more likely to require stops. Therefore, an average speed of 7 miles per hour is reasonable.

The commenter does not provide evidence supporting the claim that average BRT speeds are between 20 and 25 miles per hour. It is possible that BRT routes achieve maximum speeds of between 20 and 25 miles per hour, but unlikely that they achieve this speed over the length of their route, particularly if they are traveling through industrial areas and making a series of right-angle turns through signalized intersections as would be required by the proposed route around the slough. If anything, the 20-25 mph speed would be more likely to apply to the route across the bridge, since it would be straight and unobstructed and would have adequate distance to achieve its maximum speed.

As described above, the travel time estimates were calculated based on typical average speeds provided by SFMTA and are correct (Fehr & Peers, Memo to Planning Department documenting SFMTA's Transit Operating Speed Assumptions).

The Transportation Study (provided as Appendix D of the Draft EIR) and the text of the Draft EIR itself are consistent. Neither the Transportation Study nor the Draft EIR identified a new significant impact to Route 28L associated with Alternative 2. However, both the Transportation Study and the Draft EIR note that Alternative 2 would not provide the same quality in terms of travel times, reliability, and ridership on the 28L as would be provided by the Project.

## Response to Comment 82-31

The 28L-19th Avenue/Geneva Limited would be extended from the Balboa Park BART station east along Geneva Avenue into the Project site. East of Bayshore Boulevard, the 28L-19th Avenue/Geneva Limited would provide the Bus Rapid Transit service extending across Yosemite Slough bridge into the Hunters Point Shipyard. The Project's impacts to this line are due to Project-generated traffic congestion at and just west of the Bayshore Boulevard/Geneva Avenue intersection, when the 28L would operate in mixed-flow travel lanes.

It is not clear to what data the commenter is referring. It is possible that the commenter is referring to Tables 77 and 83 in the Transportation Study in Appendix D of the Draft EIR. Table 77 presents the additional transit vehicles that would be necessary on each route serving the Project study area to maintain headways due to the Project and Variants 1 and 2. Table 83 presents the same information for Project Alternatives. If this is the data to which the commenter is referring, the comment contains a misrepresentation of the data.

Table 83 illustrates that based on long-term growth in traffic congestion in the study area, which would increase transit travel times, if Alternative 1 (No Project) occurred, a total of 16 additional buses would be necessary to maintain proposed transit headways in the study area in both the AM and PM peak hours. This includes only one additional vehicle for the 28L in both peak hours.

Table 77 illustrates that with implementation of the Project (and associated increases in traffic congestion, which would increase transit travel times) using SFMTA's Service Planning model in consultation with SFMTA, a total of 7 additional vehicles would be needed in the AM peak hour and 12 vehicles in the PM peak hour to maintain headways on all transit lines serving the study area. This includes one additional vehicle on the 28L-19th Avenue/Geneva Limited in each peak hour compared to Alternative 1 (No Project).

Table 83 shows that with implementation of Alternative 2, the 28L-19th Avenue/Geneva Limited would require the same number of additional vehicles (one) as required by the Project to maintain proposed headways, associated with traffic congestion-related delays only. However, the additional travel time around Yosemite Slough under Alternative 2 without the bridge would require an additional 2 vehicles on the 28L BRT, compared to the Project. These additional vehicles are not reflected in Table 83, which is summarizing the effects of traffic congestion related transit delays only.

### Response to Comment 82-32

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) for discussion of stadium traffic egress for Alternative 2. The existing stadium is situated adjacent to a single freeway interchange. A very large portion of post-game traffic is routed to this single interchange, which is typically overwhelmed following games, limiting the capacity of autos to exit the stadium. The new stadium would be situated such that it has two primary routes to regional freeways—the route over Yosemite Slough toward Harney Way and the reconstructed US-101/Harney Way interchange and the route along Innes Avenue/Evans Avenue/Cargo Way which opens up direct connections from the stadium to other regional freeway entrances at Cesar Chavez Street, Indiana Street, and Bayshore Boulevard/Alemany Boulevard (refer to Figure III.D-15 [Stadium Game Day Egress Routes] on Draft EIR page III.D-130).

### Response to Comment 82-33

It is possible that providing extremely difficult stadium egress would promote a shift from private auto to transit. However, the shift would not be so great as to reduce stadium clearance times to within standards set by the NFL (i.e., 1 hour for average game). For example, the proposed bridge would accommodate approximately 4,000 vehicles per hour following games. The average auto occupancy for game day attendees is 2.6 persons per auto, according to data provided by the 49ers. In order to maintain the stadium clearance times provided by the Project, which includes the Yosemite Slough bridge, the 10,400 people per hour who would otherwise use the bridge (4,000 vehicles per hour x 2.6 persons per vehicle) would have to switch to transit. When added to the 17,040 persons per hour already forecasted to use transit to access the stadium, the stadium's transit mode share would more than double, increasing from 19 to 40 percent, with 27,440 transit riders.

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) for discussion of importance of bridge related to new stadium.

## Response to Comment 82-34

The comment summarizes Comments 82-23 to 82-33. Refer to Responses to Comments 82-23 to 82-33 as well as Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge). No further response required.

## Response to Comment 82-35

In response to the comment, Section VI.C (Analysis of Project Alternatives), Draft EIR page VI-30, fourth paragraph, has been revised as follows:

> Under Alternative 2, ~~motorized traffic~~ transit and non-motorized traffic would be required to circumnavigate Yosemite Slough because no bridge would be constructed. <u>On game days, motorized and non-motorized traffic, which would travel across Yosemite Slough Bridge under the Project, would also be required to circumnavigate Yosemite Slough because no bridge would be constructed under Alternative 2.</u> Figure VI-1 (Alternative 2 Circulation Plan Railroad Right-of-Way for Bus Rapid Transit) illustrates the proposed route. The rest of the street network at Candlestick Point and HPS Phase II would be the same as the Project.

## Response to Comment 82-36

In response to the comment, the text in Section VI.C (Analysis of Project Alternatives), Draft EIR page VI-30, fifth paragraph, has been revised as follows:

> <u>Similar to the Project, under Alternative 2, </u>~~T~~<u>t</u>he primary roadway connection for automobiles and other vehicular traffic between Candlestick Point and HPS Phase II would be west on Carroll Avenue to Ingalls Street, north along Ingalls Street to Thomas Avenue, and east on Thomas Avenue to Griffith Street. Ingalls Street would remain an industrial mixed-use street with two auto lanes and parking and loading zones on its northern and southern sides. The width of sidewalks on that portion of Ingalls Street from Carroll Avenue to Yosemite Avenue would be decreased from 16 feet to 11 feet to create a uniform street width to accommodate the auto lanes, parking, and loading.

## Response to Comment 82-37

Figure VI-1 (Alternative 2 Circulation Plan Railroad Right-of-Way for Bus Rapid Transit) shows an incorrect alignment of the proposed BRT route for Alternative 2. The figure has been revised to illustrate the correct alignment. Refer to Response to Comment 82-27 for the revised figure.

## Response to Comment 82-38

The line along Innes Avenue was also in error. Figure VI-1 (Alternative 2 Circulation Plan Railroad Right-of-Way for Bus Rapid Transit) has been revised to illustrate the correct alignment. Refer to Response to Comment 82-27 for the revised figure.

## *Response to Comment 82-39*

Refer to Response to Comment 82-28 for a discussion of "rail-readiness" of the BRT route around Yosemite Slough.

## *Response to Comment 82-40*

In response to the comment, the text in Section VI.C (Analysis of Project Alternatives), the first paragraph, under the Transportation and Circulation heading, page VI-33, has been revised as follows:

> Alternative 2 would be the same as the Project, except it would not include the Yosemite Slough bridge. Because vehicular traffic could not use the bridge on non-game days, ~~T~~the main roadway connection between Candlestick Point and HPS Phase II would be the same as with the Project, via Ingalls Street. The bus rapid transit (BRT) route would be along Carroll Avenue, Hawes Street, Armstrong Avenue, and the abandoned railroad right-of-way to provide access between Candlestick Point and HPS Phase II. Alternative 2 would otherwise have the same transportation improvements as proposed with the Project.

## *Response to Comment 82-41*

The referenced paragraph states that "Alternative 2 would have similar Project and cumulative effects at study intersections." The text is clear and no changes are required.

## *Response to Comment 82-42*

In the case of the Yosemite Slough bridge, the bridge would carry four lanes of traffic inbound before games and four lanes outbound after games. Emergency vehicles would be permitted to use the BRT lanes.

The referenced text is in a paragraph discussing game-day traffic impacts. As described in the Draft EIR, game-day traffic entrance and exiting capacity would be reduced by 40 percent in Alternative 2, compared to the Project. Game-day traffic impacts may, in fact, be more severe under Alternative 2. The commenter is correct in noting that the number of lanes accessing the regional facilities and on the local street system would remain the same. No change to the text is required.

## *Response to Comment 82-43*

In response to the comment, the text in Section VI.C (Analysis of Project Alternatives), under the "Intersection Conditions" heading, page VI-34, has been clarified, as follows:

> During game days at the football stadium, with no Yosemite Slough Bridge, the entrance and exiting capacity for vehicles would be reduced about 40 percent compared to the Project; four out of a total of 11 exit lanes would be available without the bridge. As with the Project, a mitigation measure to implement a Travel Demand Management Plan for stadium events would reduce but not avoid traffic impacts, which would be significant and unavoidable.

## *Response to Comment 82-44*

The text in Section VI.C (Analysis of Project Alternatives), under Transit Impacts heading, page IV-34, has been revised as indicated in Response to Comment 82-27. Refer to Response to Comment 82-27 for revisions to Figure VI-1 and the description of the BRT route.

## *Response to Comment 82-45*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of travel time around Yosemite Slough.

## *Response to Comment 82-46*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of travel time around Yosemite Slough.

## *Response to Comment 82-47*

The text in Section VI.C (Analysis of Project Alternatives), under the "Transit Impacts" heading, page VI-34, the typographical error has been corrected, as follows:

> Although the alternative BRT route around Yosemite Slough would be technically feasible, it would not be an optimal configuration for the BRT system. BRT service would provide direct, fast, and reliable travel in a dedicated right-of-way, typically with signal priority for B~~V~~RT vehicles, …

## *Response to Comment 82-48*

While the transportation impacts of the Project and Alternative 2 would be the same or similar, the Project Objectives would not be met at the same level. Table VI-4, page VI-59, provides a summary of the Project Objectives and indicates whether the Alternative meets those objectives. Two of the objectives of the Project are met to a lesser extent than the Project. Because game day access would be reduced by 40 percent with Alternative 2, and because the BRT would not be an optimal configuration, Alternative 2 does not meet the Project objective 1 and 2 to the same extent as the Project. Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) regarding the need for the bridge.

## *Response to Comment 82-49*

With regard to meeting the Project Objectives, refer to Response to Comment 82-48. Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) regarding the need for the bridge.

Refer to Master Response 4 and Responses to Comments 47-4 and 82-30 about the difference between the Alternative 2 BRT and the Project transit travel time. With regard to impacts related to hazards and hazardous materials, geology and soils, and biological resources, Alternative 2 reduces the number of less-than-significant impacts (impacts which can be addressed by mitigation) that would occur with the Project. Alternative 2 has the same or similar significant unavoidable impacts as the Project.

### Response to Comment 82-50

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge). Despite providing dedicated right-of-way, the route around Yosemite Slough would be substantially more circuitous with 12 to 14 additional signalized intersections and four additional right turns is therefore considered a much less direct connection across Yosemite Slough.

### Response to Comment 82-51

The commenter is referencing text that is meant to identify the utility and ease of access that a bridge at the mouth of the slough would provide for multiple modes of transit (pedestrians, bicyclists, and transit riders). The visual and physical connection at the mouth of the slough would encourage travel that would not otherwise occur.

### Response to Comment 82-52

Refer to Response to Comment 82-48 with regard to meeting the Project Objectives, and 82-50 regarding a much less direct connection across Yosemite Slough for Alternative 2, compared to the bridge alternative. The commenter is mistaking the text in the Draft EIR which describes how a crossing of Yosemite Slough would provide benefits that would not accrue without a direct bridge connection. The analysis does not refer to grade separation as the distinguishing factor of the bridge. What is referenced is the utility and ease of access that a bridge at the mouth of the slough would provide for multiple modes of transit (pedestrians, bicyclists, and transit riders). The visual and physical connection at the mouth of the slough would encourage travel that would not otherwise occur. Bicyclists and pedestrians are more likely to travel across the slough as the bridge would provide longer views and quicker access to the shoreline.

### Response to Comment 82-53

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Response to Comment 82-50 regarding a less direct connection across Yosemite Slough for Alternative 2 as compared to the bridge alternative.

### Response to Comment 82-54

Comment noted.

### Response to Comment 82-55

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) regarding the need for the bridge. Refer to Responses to Comments 47-4 and 82-30 about the difference between the Alternative 2 BRT and the Project transit travel time.

### *Response to Comment 82-56*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) for discussion of post-game traffic flow under conditions without the Yosemite Slough bridge. Also refer to Response to Comment 82-32 for discussion of capacity constraints at regional transportation facilities.

### *Response to Comment 82-57*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) for discussion of post-game traffic flow under conditions without the Yosemite Slough bridge and discussion of comments by the National Football League stating that a bridge across Yosemite Slough would be crucial to facilitating a new stadium at the Hunters Point Shipyard site.

### *Response to Comment 82-58*

The text in Section VI.D (Environmentally Superior Alternative), page VI-160 has been revised as indicated in Response to Comment 82-26.

### *Response to Comment 82-59*

The text in Section VI.D (Environmentally Superior Alternative), page VI-160 has been revised as indicated in Response to Comment 82-26.

### *Response to Comment 82-60*

The routes toward Ingalls Street and across Yosemite Slough would generally deliver traffic from the new stadium to the same streets that are currently used to provide stadium egress (Harney Way, Carroll Avenue, and Gilman Avenue). The analysis assumes only a modest increase in capacity of the reconstructed Harney Way interchange compared to existing conditions. Alone, these routes across Ingalls Street and over Yosemite Slough are expected to offer similar capacity to their current capacity following games at Candlestick Park. The improvement in stadium clearance time is due in large part to the location of the stadium, which allows a second main exit route, along Innes Avenue, which provides connections to other regional freeway entrances. No further analysis is required to demonstrate capacity on Carroll Avenue, Gilman Avenue, or Harney Way because the analysis assumes they would have similar exiting capacity to existing conditions.

### *Response to Comment 82-61*

This comment is similar to Comment 82-44. Refer to Response to Comment 82-27 for revisions to Figure VI-1 and description of the BRT route.

### *Response to Comment 82-62*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of BRT travel time around Yosemite Slough.

### *Response to Comment 82-63*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of BRT travel time around Yosemite Slough.

### *Response to Comment 82-64*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of BRT travel time around Yosemite Slough.

### *Response to Comment 82-65*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of BRT travel time around Yosemite Slough.

### *Response to Comment 82-66*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of BRT travel time around Yosemite Slough.

### *Response to Comment 82-67*

Refer to Master Response 4 (Purpose and Benefits of the Yosemite Slough Bridge) and Responses to Comments 47-4 and 82-30 for an estimate of BRT travel time around Yosemite Slough.

### *Response to Comment 82-68*

The comment refers to the statement that the 28L-19$^{th}$ Avenue/Geneva Limited would experience increases in travel time due to Project-generated traffic. The comment notes that this route currently operates between Daly City and the Presidio, several miles west of the Bayview neighborhood, making it unlikely that Project-generated traffic would affect this route. However, the 28L-19$^{th}$ Avenue/Geneva Limited would be extended from the Balboa Park BART station east along Geneva Avenue into the Project site. East of Bayshore Boulevard, the 28L-19$^{th}$ Avenue/Geneva Limited would provide the Bus Rapid Transit service extending across Yosemite Slough bridge into the Hunters Point Shipyard.

The Project's impacts to this line are due to Project-generated traffic congestion at and just west of the Bayshore Boulevard/Geneva Avenue intersection, when the 28L would operate in mixed-flow travel lanes. As noted in the Draft EIR, Geneva Avenue would be extended from its current terminus at Bayshore Boulevard east to connect with Harney Way at US-101.

### *Response to Comment 82-69*

The commenter has submitted a preliminary design report for a proposed stormwater treatment wetland. The comment is not a direct comment on environmental issues or the content or adequacy of the Draft EIR. The comment will be forwarded to the decision makers for their consideration prior to approval or denial of the Project.

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