Biological Assessment
And
Essential Fish Habitat Assessment

For
Construction and Long-term Operations and Maintenance of a Ferry Terminal and Stormwater Discharges Located on Treasure Island

Prepared for:
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, CA 94103

Prepared by:
Hanson Environmental, Inc.
446 Green View Ct
Walnut Creek, CA 94596

And

Mosaic Associates
1690 San Pablo Avenue, Suite D
Pinole, CA 94564

For

Treasure Island Development Authority (TIDA)
One Avenue of the Palms
San Francisco, CA 94130

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ES-1. EXECUTIVE SUMMARY

This Biological Assessment (BA) has been prepared to complete consultation with the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act (ESA), and for Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), for the construction and long-term operations and maintenance of a ferry terminal located on Treasure Island and the installation and operations of additional stormwater discharges associated with residential and commercial development on Treasure Island (TI) and Yerba Buena Island (YBI). This BA is intended to support consultation with NMFS by the U.S. Army Corps of Engineers (ACOE), the federal agency with jurisdiction over the project activities.

This BA presents technical information about the Proposed Project and resulting actions, and assesses potential effects to threatened, endangered, or proposed threatened or endangered aquatic species and their habitats, as well as potential impacts to EFH due to those actions. The Action Area, as defined in 50 Code of Federal Regulations (CFR) § 402.02, includes all areas to be directly or indirectly affected by the federal actions, as well as interrelated and interdependent actions.

The Action Area for this Proposed Project is described in Section 3. The action area includes Central San Francisco Bay in the vicinity of TI (Figure ES-1). The Action Area is known to contain and provide potential critical habitat for the following federally threatened or endangered species:

- Green Sturgeon (Acipenser medirostris);
- Steelhead, Central California Coast ESU (Oncorhynchus mykiss);
- Steelhead, California Central Valley ESU (Oncorhynchus mykiss);
- Chinook salmon, Central Valley (Sacramento) spring-run (Oncorhynchus tshawytscha); and
- Chinook salmon, Central Valley (Sacramento) winter-run (Oncorhynchus tshawytscha).

The Treasure Island Development Authority (TIDA) and Treasure Island Community Development (TICD) are seeking a permit from the ACOE for construction and long-term operations and maintenance of a ferry terminal on TI and additional stormwater discharges located on both islands associated with redevelopment of the existing naval facilities and expansion of residential and commercial development on the islands. This BA will serve as a basis for NMFS determinations regarding take of listed salmonids and green sturgeon and potential adverse modification of their critical habitat as a result of the proposed actions. The BA also serves as the basis to assess potential effects of the proposed action on EFH. Juvenile

Chinook salmon, steelhead, and green sturgeon, as well as managed fish species (Pacific salmon, starry flounder, northern anchovy, English sole, and a number of other managed fish species) inhabit areas of the Bay-Delta estuary where construction and operations activities associated with the ferry terminal and stormwater discharges on the islands would occur. Some of these species use the area as a migratory corridor while others reside in the areas for more extended periods of time as juvenile rearing habitat. Information presented in this BA may also be used by the California Department of Fish and Wildlife (CDFW) to assess potential effects of the proposed project on fish listed for protection under the California Endangered Species Act (CESA) including longfin smelt, winter-run and spring-run Chinook salmon.

Figure ES-1: Regional Location
(Pacific EcoRisk, 2014)

Delta smelt, a species listed for protection under both California and federal ESA inhabit the estuary further upstream but do not occur in Central San Francisco Bay and are not addressed as part of this BA. Coho salmon potentially occur in Central Bay, however, they do not spawn or rear in Central Valley rivers but rather use coastal tributaries as spawning and rearing habitat and therefore have not been included in this BA.

The project description is provided in Section 4, and includes details of the proposed ferry terminal and stormwater outfall locations, construction methods, equipment, volumes, and characteristics of construction activity and long-term operations and maintenance activities.

The proposed action also includes avoidance and minimization measures described in Section 4.2 as part of the project description and basis for this BA. As part of construction activities and long-term operations and maintenance of the ferry terminal and additional stormwater discharges on the islands associated with the proposed project TIDA will employ a variety of conservation measures designed to avoid and minimize potential adverse effects to aquatic resources. The conservation measures provide increased protection for all aquatic resources within the estuary including listed salmonids and green sturgeon and their critical habitat, as well as the other listed species, critical habitat and Essential Fish Habitat within Central San Francisco Bay. These conservation measures (Best Management Practices – BMPs) and mitigation measures identified in the final project Environmental Impact Report (City and County of San Francisco, April 2011) and the final programmatic Environmental Impact Reports for expansion of ferry transit service in the Bay Area (URS 2003) to reduce and avoid adverse impacts to fish and aquatic habitats, which are included specifically as part of the proposed action evaluated in this biological assessment, are provided below.

- Follow manufacture's recommendations on use, storage and disposal of chemical products used in construction;
- All refueling and maintenance activities shall occur at a dedicated area that is equipped with containment improvements and readily available spill control equipment and products. Overtopping construction equipment fuel gas tanks shall be avoided;
- During routine maintenance of construction equipment, properly contain and remove grease and oils;
- Properly dispose of discarded containers of fuels and other chemicals;
- Conduct an annual review of the Harbor Safety Plan;
- Update contingency plans and reviews of emergency response services. Review contingency plans, conduct drill exercises, and review emergency response agreements. Review emergency response equipment availability;
- Develop a program for training on fueling methods to minimize spills;

- Require review of new vessels to include technological features to minimize spills;
- Adopt applicable measures recommended by the Ferry Safety Plan;
- Adopt measures for construction to prevent, minimize, and clean up spills and leaks. Require containment measures for equipment that could potentially release fuels;
- Design new terminals to control storm water runoff and discharge;
- Conduct turbidity monitoring and management during ferry terminal construction and channel dredging. Use silt curtains or other techniques in accordance with DMMO recommendations for reducing dredging impacts. Dredge spoils will not be discharged into the Bay but will be placed on land for beneficial reuse;
- Disturbance of eelgrass beds and mudflats shall be avoided in the design of project features and routes. Site specific sidescan sonar surveys would be required prior to implementation of new routes or construction of new terminals to verify that eelgrass is not present. Avoid indirect impacts through use of silt curtains or methods to protect eel grass, mudflats, and native oysters from disturbance;
- Sound pressure monitoring and response during pile driving and sheet pile installation shall be conducted. Underwater sound pressure levels will be monitored during pile driving. A sound pressure threshold of 160 dB at 500 meters from the source was established in the EIR for triggering avoidance measures. If the threshold sound level is exceeded or avoidance response by fish is observed by an on-site marine biologist bubble curtains will be used to reduce sound/vibration to acceptable levels. In addition, the final ferry terminal design will use as few piles as possible, a vibratory hammer will be used for all steel piles, cushion blocks will be used between the hammer and pile, and pile driving will be restricted to the period June 1 to November 30 to avoid potential impacts to salmonids and Pacific herring;
- Consolidate ferry routes to leave as much undisturbed shallow open water habitat as possible;
- Restriction of construction activities – activities in the lower intertidal and near subtidal zone shall be minimized to the maximum extent practicable;
- Seasonal limitations on in-water construction will be limited to the period from March 16 through November 30;
- Eel grass bed surveys and avoidance will include periodic surveys and avoidance measures of impacts to eel grass beds;
- Erosion and sediment control measures shall be implemented; and

- Stormwater management and drainage pollutant prevention shall be implemented including pre-discharge treatment.

Existing conditions for listed salmonids and green sturgeon are described in Section 5. The potential direct and indirect effects of the proposed project on listed salmonids and green sturgeon, and their designated critical habitat, in addition to EFH are analyzed in Section 6 of this assessment, and include consideration of the following issues:

- Exposure to increased suspended sediment concentrations and turbidity;
- Exposure to contaminants and toxicity;
- Changes to dissolved oxygen levels;
- Spread of invasive species;
- Increased shading;
- Effects of sound pressure (noise);
- Migration and habitat use;
- Benthic disturbance; and
- Effects on habitats of particular concern.

Based on results of the assessment it was concluded that the proposed project within Central San Francisco Bay may affect, but is not likely to adversely affect, protected and managed fish species directly through avoidance behavior of sublethal increases in suspended sediments and turbidity associated with dredging activity, behavioral avoidance of the construction area during installation of concrete piles using the impact hammer, increased shading, migration and habitat use, and benthic disturbance. The Project Description and implementation of measures designed to avoid and minimize incidental take of winter-run and spring-run Chinook salmon, Central Valley and Central California Coast steelhead or green sturgeon will not result in jeopardy to the continued existence of these species or significant adverse modification to their critical habitat.

This BA concludes that the proposed project is not likely to adversely affect the continued existence of winter-run or spring-run Chinook salmon, Central Valley or Central California Coast steelhead, or green sturgeon (non-jeopardy) or result in adverse modification to their critical habitat.

1.0 INTRODUCTION

Treasure Island (TI) and Yerba Buena Island (YBI) are located in Central San Francisco Bay, about halfway between the San Francisco mainland and Oakland (see Figure 1.1). The Islands are the site of the former Naval Station Treasure Island ("NSTI"), which is owned by the U.S. Navy. NSTI was closed on September 30, 1997, as part of the Base Realignment and Closure Program. The Islands also include a U.S. Coast Guard Station and Sector Facility, a U.S. Department of Labor Job Corps campus, and Federal Highway Administration ("FHWA") land occupied by the San Francisco-Oakland Bay Bridge ("Bay Bridge") and tunnel structures.

The Treasure Island Development Authority ("TIDA") is proposing to redevelop the portions of NSTI still owned by the Navy. The Development Plan will be carried out by Treasure Island Community Development, LLC ("TICD").

Currently, the former military base consists primarily of low-density residential uses, along with vacant and underutilized non-residential structures, existing and former non-residential uses, parking and roadways, open space, a wastewater treatment facility, and other infrastructure. The Development Plan Area will be redeveloped with a new, high-density, mixed-use community with a variety of housing types, a retail core, open space and recreation opportunities, on-site infrastructure, and public and community facilities and services. In all, there will be up to 8,000 residential units, 450,000 square feet (sq. ft.) of new commercial and retail space; up to 500 hotel rooms and a cultural center; a new ferry terminal and transit program; approximately 300 acres of parks and open space; an approximately three-mile long shoreline trail on the islands; and new and/or upgraded public services and utilities including a new or upgraded wastewater treatment plant and a new recycled water plant.

Figure 1.1: Regional Location
(Pacific EcoRisk, 2014)

Implementation of the Development Plan will be phased over a 10-15 year period. The TIDA/TICD is applying for an Individual Permit (IP) from the Army Corps of Engineers and a Water Quality Certification from the Regional Water Quality Control Board for the discharge of fill and dredging in waters of the U.S. associated with construction of the ferry terminal and renovation of the existing storm drain outfall system. TIDA/TICD will also apply for a major permit from the San Francisco Bay Conservation and Development Commission (BCDC) for those same activities as well as improvements to the shoreline revetment on TI and trails within BCDC jurisdiction on TI and YBI.

This Biological Assessment (BA) has been prepared on behalf of TIDA as part of the Section 7 consultation process between the U.S. Army Corps of Engineers (ACOE) and the National Marine Fisheries Service (NMFS). The Proposed Project is construction and long-term operations and maintenance of a ferry terminal, as well as stormwater discharges associated with redevelopment of TI and YBI. The purpose of this BA is to review in sufficient detail the Proposed Project activities that would potentially affect fish and aquatic habitat. This BA also determines to what extent the Proposed Project construction activities and long-term operations and maintenance may affect aquatic species listed as threatened, endangered or candidate species along with any designated or proposed critical habitats identified in the Action Area. It specifically evaluates the effects of potential federal actions necessary to permit the Proposed Project. This BA identifies species listed under the Federal Endangered Species Act (ESA) and Essential Fish Habitat (EFH) that have the potential to be directly or indirectly affected by the Proposed Project.

1.1. REGULATORY REQUIREMENTS

This document presents the ACOE's Biological Assessment (BA) for consultation with the NMFS under Section 7 of the ESA and under Section 305(b) for EFH evaluation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the elements of the proposed TI redevelopment project within Central Bay (project) that may adversely affect fish and aquatic habitat. This BA presents technical information about the project in sufficient detail to determine to what extent the Proposed Project may affect any of the threatened, endangered or proposed species and designated or proposed critical or essential habitats identified in the Action Area. In addition, the following information is provided to comply with statutory requirements to use the best scientific and commercial information available when assessing the risks posed to listed and/or proposed species and designated and/or proposed critical habitat by federal actions. This BA is prepared in accordance with legal requirements set forth under regulations implementing Section 7 of the ESA (50 CFR 402; 16 U.S.C. 1536 (c)) and Section 305(b) of the MSA. 50 CFR 402.16(b) would require re-initiation of consultation if any change in the project description may affect listed species and has not previously been analyzed.

1.2. THREATENED, ENDANGERED, OR PROPOSED SPECIES COVERED IN THIS BIOLOGICAL ASSESSMENT

1.2.1. ESA Protected Species

The following ESA listed threatened, endangered, proposed threatened/endangered species may be affected by the proposed action:

- Green Sturgeon (Acipenser medirostris);
- Steelhead, Central California Coast ESU (Oncorhynchus mykiss);
- Steelhead, California Central Valley ESU (Oncorhynchus mykiss);
- Chinook Salmon, Central Valley (Sacramento) spring-run (Oncorhynchus tshawytscha); and
- Chinook salmon, Sacramento River winter-run (Oncorhynchus tshawytscha).

Delta smelt, a species listed for protection under both California and federal ESA inhabit the estuary further upstream but do not occur in Central San Francisco Bay and are not addressed as part of this BA. Coho salmon potentially occur in Central Bay, however, they do not spawn or rear in Central Valley rivers but rather use coastal tributaries as spawning and rearing habitat and therefore have not been included in this BA.

1.2.2. Critical Habitat

The action addressed within this document would occur within Critical Habitat identified for:

- Green Sturgeon (Acipenser medirostris)
- Steelhead, Central California Coast ESU (Oncorhynchus mykiss)
- Steelhead, California Central Valley ESU (Oncorhynchus mykiss)
- Chinook Salmon, Central Valley (Sacramento) spring-run (Oncorhynchus tshawytscha)
- Chinook Salmon, Sacramento River winter-run (Oncorhynchus tshawytscha)

In addition to the fish species listed for protection under the federal ESA, longfin smelt, winter-run and spring-run Chinook salmon are also listed for protection under CESA and are known to occur in the Action Area.

1.2.3. Essential Fish Habitat

The Action Area addressed within this document falls within Essential Fish Habitat, as defined in the MSA, for 20 species of commercially important fish and sharks managed under three

federal fisheries management plans (FMPs): the Pacific Groundfish FMP, the Coastal Pelagic FMP, and the Pacific Coast Salmon FMP.

Coastal Pelagic EFH: The Coastal Pelagic FMP is designed to protect habitat for a variety of fish species that are associated with open coastal waters. Fish managed under this plan include planktivores and their predators. Those found in Central San Francisco Bay include northern anchovy, Pacific sardine, and jack mackerel.

Pacific Groundfish EFH: The Pacific Groundfish FMP is designed to protect habitat for more than 90 species of fish, including rockfish, flatfish, roundfish, some sharks and skates, and other species that associate with the underwater substrate. Fifteen (15) species are reported present in Central San Francisco Bay waters and include English sole, sand sole, curlfin sole, Pacific sanddab, starry flounder, lingcod, brown rockfish, Pacific whiting, kelp greenling, leopard shark, spiny dogfish shark, skates, soupfin shark, bocaccio, and cabezon.

Pacific Salmon EFH: The Pacific Salmon FMP is designed to protect habitat for commercially important salmonid species. Chinook salmon is the only one of these species that may be seasonally present in the Action Area although historically Coho salmon were reported in San Francisco Bay.

1.2.4. Habitat Areas of Particular Concern (HAPC)

Within the San Francisco Bay-Delta, NMFS has identified two habitat areas of particular concern. They include:

- Eelgrass beds (*Zostera marina*); and
- Native Olympia oyster beds (*Ostrea lurida*).

2.0 CONSULTATION HISTORY

Informal consultations and discussions with resource and regulatory agencies regarding the assessment of potential adverse effects due to TI and YBI redevelopment on the aquatic resources of San Francisco Bay began in September 2014 with an ACOE pre-application meeting. Subsequently a meeting was held with NMFS and CDFW in early October 2014 to further discuss the proposed project description and the approach to assessing potential adverse effects. Although a variety of potential impact mechanisms were discussed at the meeting the primary emphasis focused on construction-related effects associated with underwater sound pressure levels during installation of pilings and the sheetpile breakwaters.

Since the only fish species listed under the federal ESA under the authority of the US Fish and Wildlife Service (USFWS) that inhabits the Bay-Delta estuary is the delta smelt which does not occur in Central San Francisco Bay, no consultation with USFWS has taken place regarding aquatic species.

3.0 ACTION AREA

The Action Area for the proposed project is located in Central San Francisco Bay in the vicinity of Treasure Island (Figure 1.1). Specific areas adjacent to Treasure Island where construction and long-term operations of the proposed ferry terminal are shown in Figure 3.1. Areas located on Treasure Island and Yerba Buena Island where additional stormwater discharges would be located are shown on Figure 3.2. Construction and operations effects of the proposed project would be limited to only those areas in Central Bay in the immediate vicinity of the ferry terminal (Figure 3.1) and stormwater discharges (Figure 3.2).

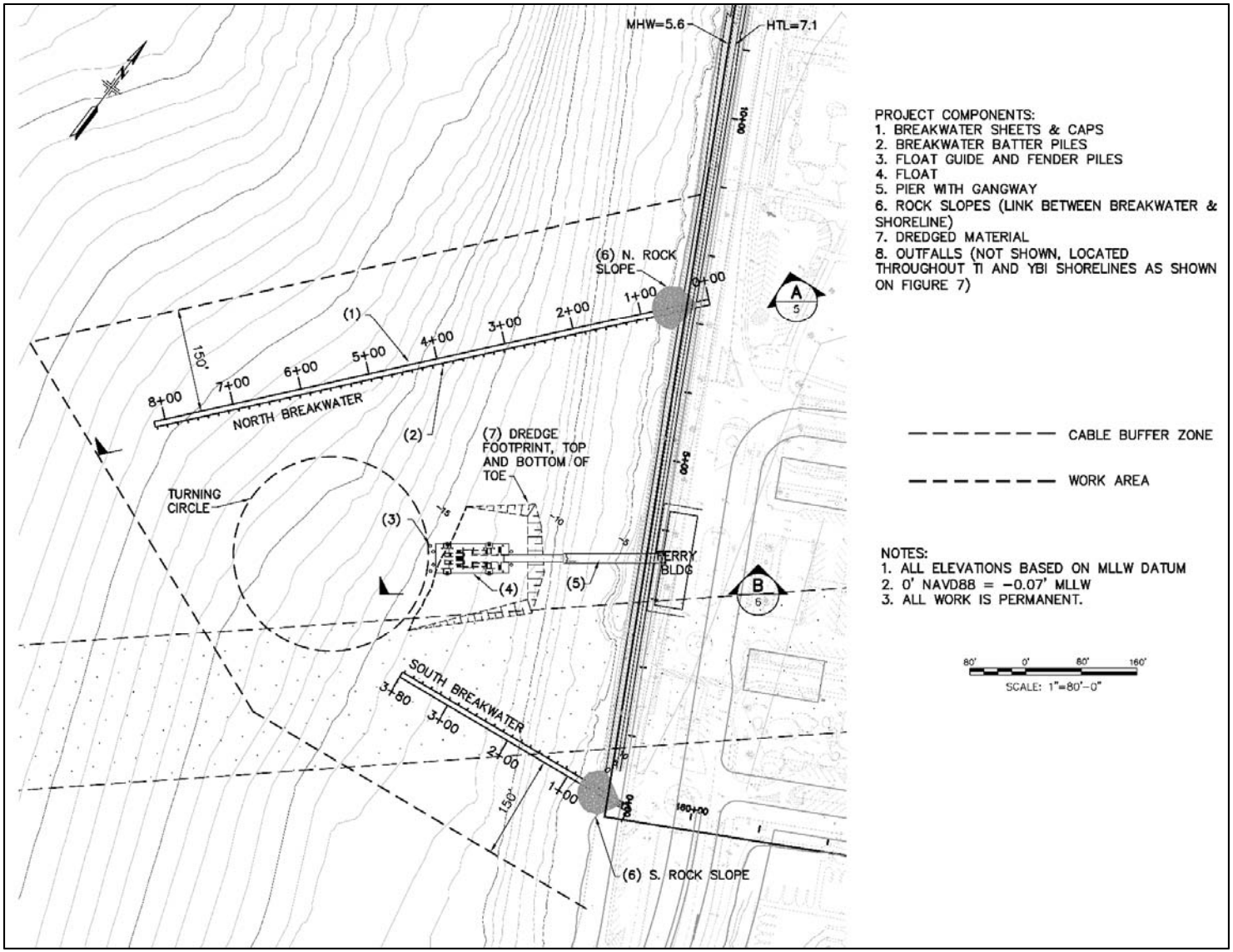


Figure 3.1: Ferry Terminal Site Plan

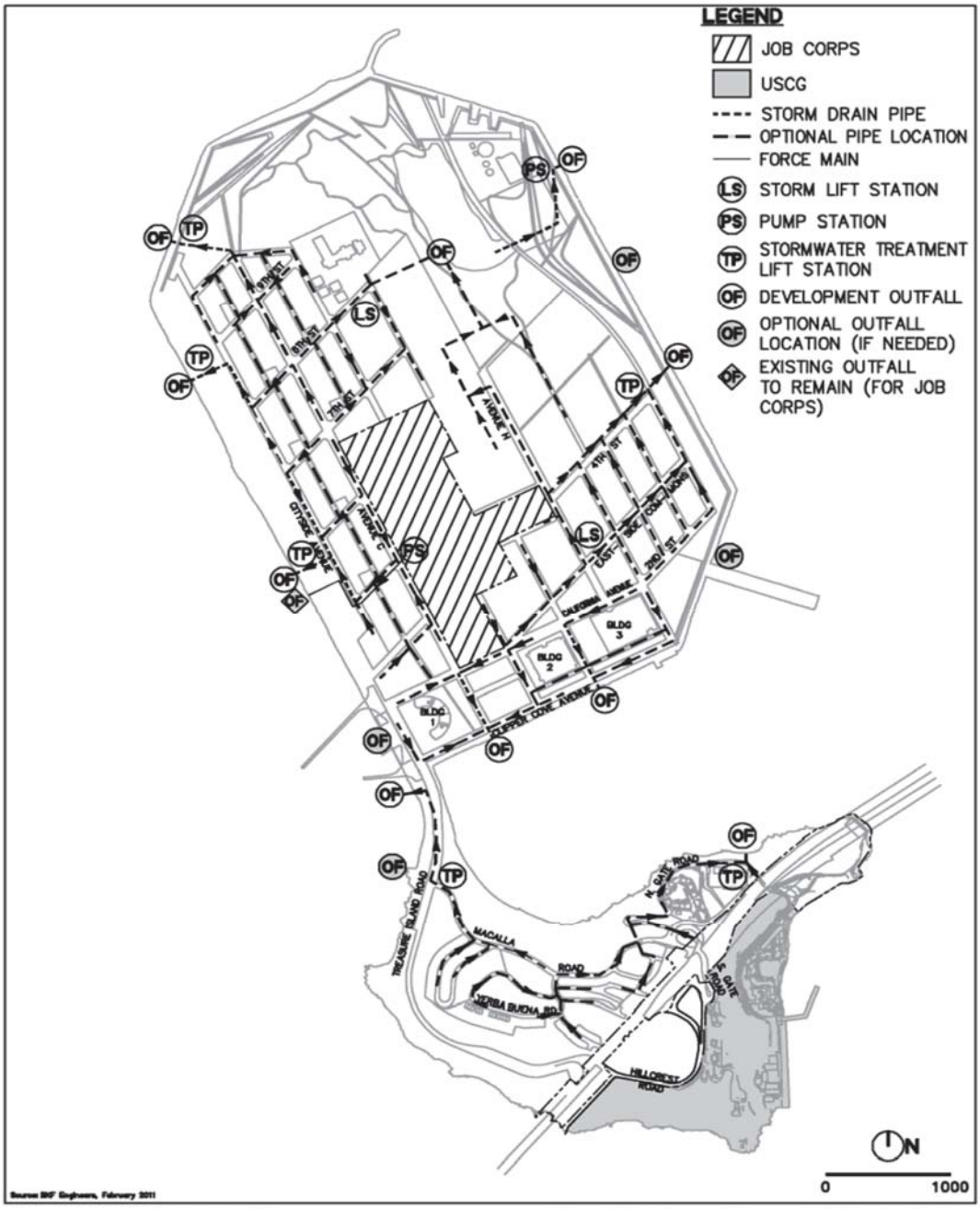


Figure 3.2: Proposed Stormwater Collection System Plan

(Treasure Island Infrastructure Plan, Figure 12.1)

4.0 PROJECT DESCRIPTION

Treasure Island contains approximately 404 acres of land, and YBI approximately 160 acres. The project will convert approximately 367 acres on TI and approximately 94 acres on YBI from a former military base to a mixed-use development that includes overs 300 acres of open space.

The redevelopment of TI and YBI includes: up to 8,000 residential units; 450,000 square feet of retail space; up to 500-hotel rooms and a cultural center; a new ferry terminal and transit program; approximately 300 acres of new public parks and open space; an approximately 3 - mile-long public shoreline trail around TI and various trails on YBI. The project would redevelop both TI and YBI over four phases spanning 10 to 15 years (see Figure 4.1). Open space management on YBI will be implemented consistent with the Yerba Buena Island Habitat Management Plan (HMP).

There are five primary components to the redevelopment of TI and YBI, including: (1) residential; (2) open space and recreation; (3) transportation; (4) commercial and adaptive reuse; and (5) community and public facilities. Figure 4.1 depicts the locations of these redevelopment components and their location relative to each major phase of development.

Redevelopment of TI and YBI will require earthwork, geotechnical stabilization of TI and the causeway connecting it to YBI, the importation of fill material to raise the surface elevation of TI to address flood protection and potential sea level rise, selective removal of trees and vegetation, demolition of buildings and other structures, and construction of new structures and infrastructure during the four phases of the project.

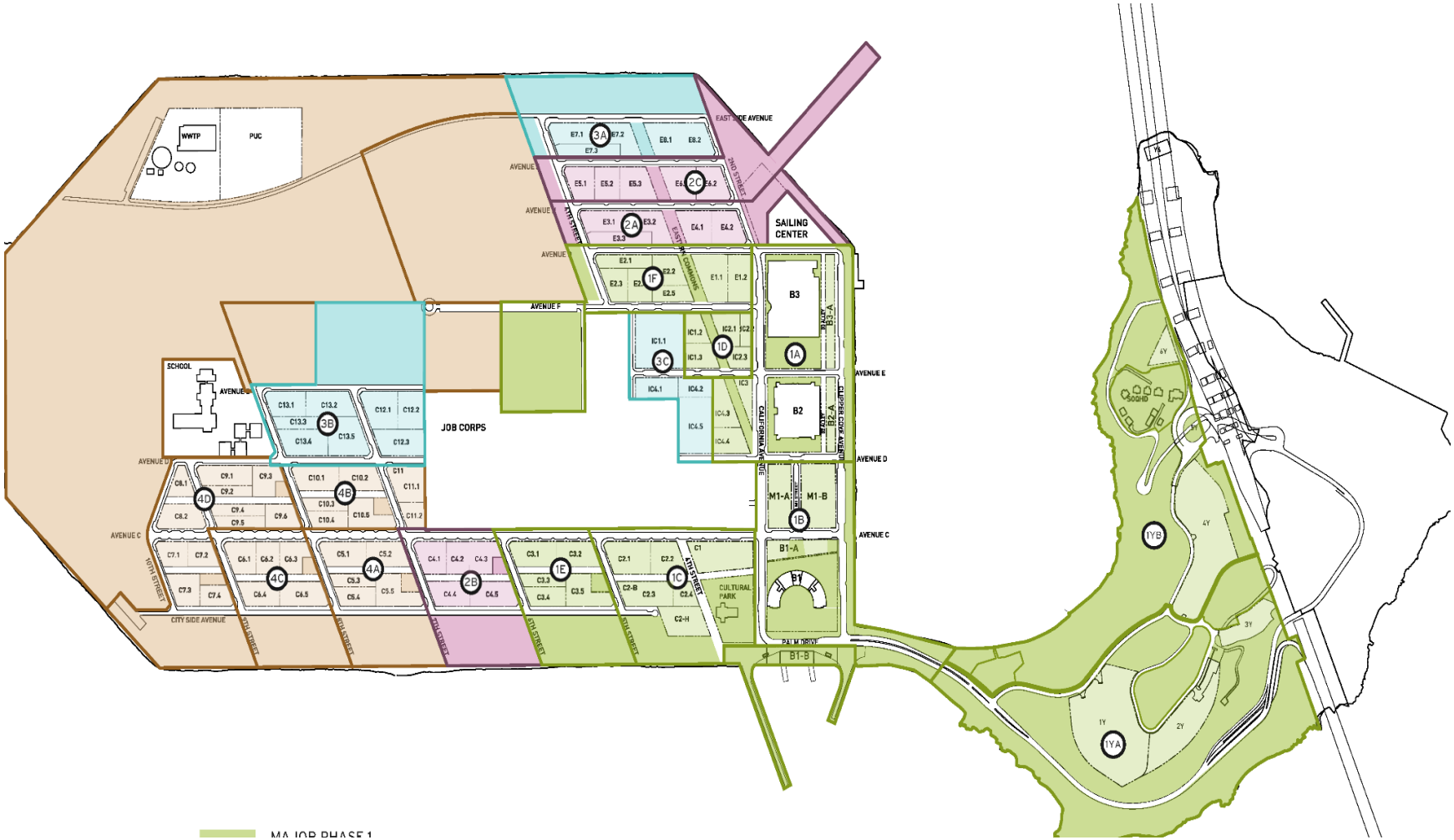


Figure 4.1: Redevelopment Phasing Plan

(Disposition & Development Agreement, Exhibit II, Phasing Plan, June 28, 2011)

4.1. PROJECT COMPONENTS IN WATERS OF U.S.

Two project components require dredging or the discharge of fill material into waters of the U.S. They are: a) construction and operation of a new ferry terminal; and b) improvements to existing drainage structures and outfalls. A description of each of these project elements is provided below. Construction methods, materials, equipment, timeline, project phase in which construction will occur and impacts on open water and shoreline habitat, as well as fish and wildlife are described. A phasing schedule for construction is provided in Table 4-1.

The residential, open space, commercial, community and public facilities elements of the project do not entail any work in waters of the U.S.

4.1.1. Ferry Terminal

Located at the southwest corner of TI, a new ferry quay and terminal will be constructed to provide service to downtown San Francisco (Figure 3.1). Once a ferry operator has been selected and the terminal has been constructed, the ferry service will be operated, with initial runs at approximately 60-minute intervals. The goal will be to provide service to downtown San Francisco at 15-minute intervals at peak periods from 5am to 9pm at full build-out of the project.

The ferry terminal will include two side-loading ferry slips (where ferry boat loads passengers) that will have capacity to accommodate demand increases in the future. The land access to the ferry slip includes an access pier, an ADA- compliant gangway, a steel or concrete float that would be anchored by six guide piles and mooring dolphins to protect the ferry from bumping against the float and other structures. The float will have mooring fittings and access platforms on each side to allow two ferries to moor at the float at the same time, providing two slips.

To protect the ferry slips and allow ferry service to continue in the exposed wave climate of SF Bay, the project includes an approximately 200- to 300- foot-wide west-facing basin with angled breakwaters.

The ferries themselves will be able to hold approximately 149 to 399 passengers, and will be approximately 140 feet long and 55 feet wide with a draft of up to eight feet. Up to two vessels could overnight at the ferry terminal, and routine operations, such as sewage pump-out, filling potable water storage containers, and light maintenance will occur at the terminal.

Construction of the ferry quay and terminal entail construction of the following elements in waters of the U.S.:

- Breakwaters;
- Rock slope linkage of shoreline to the breakwater ;
- Pier with foundation piles, gangway and float (including guide and fender piles);

- Dredging; and
- Slope protection improvements (repair voids, dress side slopes, etc.).

The project includes approximately 0.15 acres (6,460 square feet) of fill for the ferry terminal facilities, and 0.12 acres (5,200 square feet) of floating fill. In order to create a navigable basin, the project proponents are proposing to dredge approximately 6,000 cubic yards to a depth of about -14 feet (plus 2 feet of over-depth allowance, total of -16 ft.). Table 4-2 below summarizes bay fill and dredging associated with the ferry terminal. Figure 3.1 provides an overview of the ferry terminal facilities.

Table 4-1: Phasing Plan Elements

(Disposition & Development Agreement, Exhibit JJ: Schedule of Performance)

6/28/2011

Major Phase	Sub-Phase	Block	Parks & Open Space [1/]	Application Outside Date [2/]	Commencement Outside Date [2/]	Completion Outside Date [2/]
1				**2012**	**2014**	**2025**
	1-Y-A	1Y-2Y-3Y		2012	2014	2016
			YBI Hilltop Park 1		2017	2018
			YBI Hilltop Park 2		2020	2021
			YBI Open Space / HMP 1		2017	2019
	1-A	B2-B3		2012	2014	2016
			Eastside Commons 1		2017	2018
			Clipper Cove Promenade 2		2017	2018
	1-B	B1-M1		2013	2015	2017
			Building 1 Plaza		2018	2019
			Marina Plaza		2018	2019
			Clipper Cove Promenade 1		2018	2019
	1-C	C1-C2		2014	2016	2018
			Cityside Waterfront Park 1		2019	2020
			Cultural Park		2019	2020
	1-D	IC1-IC4		2015	2017	2019
			Eastside Commons 2		2020	2021
	1-E	C3		2016	2018	2020
			Cityside Waterfront Park 2		2021	2022
	1-F	E1-E2		2017	2019	2021
			Urban Farm 1		2023	2024
			Eastside Park 1		2022	2023
			Eastside Commons 3		2022	2023
	1-Y-B	4Y		2018	2020	2022
			YBI Beach Park		2023	2024
			YBI Open Space / HMP 2		2023	2025
2				**2018**	**2020**	**2027**
	2-A	E3-E4		2018	2020	2022
			Sailing Center Pad		2022	2022
			Eastside Park 2		2023	2024
			Eastside Commons 4		2023	2024
			Eastern Shoreline Park 1		2023	2024
			Clipper Cove Promenade 3		2023	2024
	2-B	C4		2019	2021	2023
			Cityside Waterfront Park 3		2024	2025
	2-C	E5-E6		2020	2022	2024
			Eastside Park 3		2025	2026
			Eastside Commons 5		2025	2026
			Eastern Shoreline Park 2		2025	2026
			Pier 1		2026	2027
3				**2021**	**2023**	**2030**
	3-A	E7-E8		2021	2023	2025
			Eastside Park 4		2026	2027
			Eastside Commons 6		2026	2027
			Eastern Shoreline Park 3		2026	2027
	3-B	C12-C13		2022	2024	2026
			Urban Farm 2		2028	2029
	3-C	IC1-IC4		2023	2025	2030
4				**2024**	**2026**	**2034**
	4-A	C5		2024	2026	2028
			Cityside Waterfront Park 4		2029	2030
			Sports Park		2030	2031
	4-B	C10-C11		2025	2027	2029
			Urban Farm 3		2031	2032
	4-C	C6		2026	2028	2030
			Cityside Waterfront Park 5		2031	2032
			Urban Farm 4		2032	2033
	4-D	C7-C8-C9		2027	2029	2031
			Cityside Waterfront Park 6		2032	2033
			Northern Shoreline Park / The Wilds / Environmental Center Pad		2033	2034

6/28/2011

Community Facility	Obligation	Building Permit / Trigger [3/]	Application Outside Date [4/]	Commencement Outside Date [4/]	Completion Outside Date [4/]
		A	B	C	D
Waterfront Plaza / Ferry Terminal Phase 1	Facility	100 du	+6mo	+12mo	+36mo
Retail - Interim Grocery Store (5,000 sf)	Facility	1,000 du	+6mo	+12mo	+36mo
Police / Fire Station	Facility	2,500 du	+6mo	+12mo	+24mo
Retail - Final Grocery Store (15,000sf)	Facility	5,000 du	+6mo	+12mo	+24mo
Ferry Terminal Phase 2	Facility	As mutually agreed by WETA, Developer, and TIDA, after engaging in a meet and confer process described in the MOU between TIDA and WETA.			
WWTP / Recycled Water Plant / PUC 4-6 acres	Developable Pad	See PUC / TIDA WWTP MOA for timing of pad delivery.			
Sailing Center Pad	Developable Pad	Developer shall use commercially reasonable efforts to provide the Sailing Center Pad earlier if the Authority requests it and if the Treasure Island Sailing Center provides reasonable evidence that it will be ready to proceed with construction of the Sailing Center building at that earlier date.			
Environmental Center Pad	Developable Pad	Developer shall deliver the Environmental Center Pad commensurate with improvements for The Northern Shoreline Park and The Wilds			
Pier 1 / Eastern Shoreline Park 2	Improvements	Construction of these improvements may be deferred if the area is still needed for barging operations related to importing material for the site. In no case will the Completion Outside Date for these improvements be later than the Completion Outside Date of the last Sub-Phase.			
Buses for East Bay Service	Rolling Stock	Nine (9) Buses for East Bay Bus Service. First five (5) buses at inception of service, remaining four busses no earlier than the occupancy of the 5,000th residential unit.			
On -Island Shuttle Buses	Rolling Stock	Four (4) Shuttle Buses. Up to two (2) buses will be provided when the service initially begins, but no earlier than the occupancy of the three thousandth (3000th) unit, subject to the meet and confer process described in Exhibit N, Transportation Plan Obligations. The remaining two (2) buses will be provided as needed based on service schedules.			
Bicycle Lending Library	Rolling Stock	Purchase of bicycles and equipment to establish the bicycle lending library up to a maximum expediture of $110,000. Must be completed no later that the occupancy of the 1,000 residential unit.			

Financial Obligation	Obligation	Mechanism
Open Space Annual O&M Subsidy	$14.3 MM (NPV)	Max $1.5mil first 5 yrs, $3 mil per yr from Yr 6, subject to need per annual operating budget. See Financing Plan for amounts and schedule.
Transportation Annual Operating Subsidy	$30 MM (NPV)	Max $4 mil per year, subject to need per annual operating budget. See DDA for amounts and schedule.
Additional Transportation Subsity	$5 MM max	Five annual consecutive installments (max $1 mil per year) after the first certificate of occupancy (whether temp or final) has been issued for the 4,000th dwelling unit on the Project Site, payable within 90 days after request of SFCTA if transit report shows residential transit mode share is 50% or less.
Transportation Capital Contributions	$1.8 MM (NPV)	Used to purchase up to six (6) busses. Per-bus subsidy: the lesser of 20% of the cost of a Muni bus, or $300,000.
Community Center Space(s) Subsidy	$9.5 MM (NPV)	Space or susidy determination made at Major Phase Approval. Max $2.375 mil each Major Phase - subject to approved budget and program description.
Childcare Facility Subsidy	$2.5M (NPV)	Space or funding no later than the first approved Sub-Phase within Major Phase Three or 18 months before the existing facility is no longer operational due to development activity, whichever comes first.
Affordable Housing Subsidy	$98 MM max; $73.5 MM baseline	$17,500 per market rate unit at each lot sale. Trueups at 50% of TI land acreage make-up to 2,100 units and at 4,200 units land sales, credit for any payment made at 2,100 unit true-up. See Housing Plan for amounts and schedule
School Improvement Payment	$5 MM (NPV)	Payment due at the start of refurbishment work on the school grounds for purposes of opening a K-8 school. See DDA for amounts and schedule.
Ramps / Viaduct SFCTA Soft Cost Reimbursement	$10 MM (NPV)	Annual schedule of payments. See TIDA / SFCTA MOA 3rd Amendment for amounts and schedule.
Import Fill	$1 MM	Payment due upon removal from stockpile at rate of $3.50 per CY or for any remaining in stockpile after 12/31/2015 in 3 equal annual installments. See TIDA / D.A. McCosker Agreement.

1/ Horizontal obligations only, no vertical improvement or rehabilitation except as defined in Open Space Plan

2/ All dates are subject to navy's environmental remediation efforts provided in the Navy MOA and land transfers from Navy and TIDA

3/ Community Facility obligation is triggered by number of total building permits issued for residential dwelling units (shown in table above)

4/ Timeframes are additive: Completion Outside Date = Date of Trigger (A) + (B) + (C) + (D)

Table 4-2: Treasure Island Ferry Terminal and Storm Drain Outfalls Bay Fill and Dredging

	Bay Fill at MHW (SF)			Bay Bottom Footprint (Horiz. Projection below MHW) (SF)	Volume (CY)	
Ferry Component	**Solid**	**Shaded**	**Floating**		**Total Structure**	**Below MHW**
Breakwaters & Batter Piles	1,400	9,000		1,400	2,340	1,190
Rock Slopes	1,200			4,800	950	840
Pier & Foundation Piles	160	1,700		160	5,300	70
Gangway		1,200			90	
Float & Guide and Fender Piles	100		5,200	100	2,100	50
Dredging					-6,000	
Total ferry component	**2,860**	**11,900**	**5,200**	**6,460**	**10,780***	**2,150***
Outfalls permanent 14 total	+250 -700			3,800	+90 -280**	+50 -220**
Total Ferry & Outfalls Gross (net)	**3,110 (2,410)**	**11,900**	**5,200**	**10,260**	**10,870* (10,590*)**	**2,200* (1,980)***
	Bay Fill at MHW (Acres)			**Bay Bottom Footprint (Horiz. Projection below MHW (Acres))**		
Breakwaters & Batter Piles	0.03	0.21		0.03		
Rock Slopes	0.03			0.11		
Pier & Foundation Piles	0.00	0.04		0.00		
Gangway		0.03				
Float & Guide and Fender Piles	0.00		0.12	0.00		
Outfalls	0.01 (-0.02)			0.09		
Total Gross (net)	**0.07 (0.06)**	**0.27**	**0.12**	**0.24**		

** Dredging not included.*
***90 CY of concrete for the outfall headwalls (total structure) will be permanently placed. 280 CY of rock will be permanently removed, resulting in a loss of 190 CY of bay fill.*
Note: Some apparent errors due to rounding.

Breakwaters: Two breakwaters made of precast 12 inch-wide concrete sheet piles will be constructed surrounding the west-facing basin. An approximately 765-foot-long breakwater to the north, and an approximately 340-foot-long breakwater to the south will be constructed. The concrete sheet pile breakwater will terminate on the east side (shore) at the toe of the slope of the existing rock revetment on TI that will leave a gap between the sheets and the existing rock slope. This gap will be closed with a rock slope placed on top of the existing rock

slope and perpendicular to it. Both breakwaters will have navigation lights to mark the harbor entrance, but will otherwise not be lighted. Due to high waves overtopping the breakwaters, no public access along the breakwaters is proposed.

The breakwaters will be installed with a diesel powered impact hammer with approximately 100,000 ft-lb energy output operated from barge-mounted cranes. Concrete batter piles (24-inch octagonal at 15-foot centers) will be installed along the basin-interior side of the breakwaters. Between 50 and 60 concrete batter piles will support the north breakwater, and 20 to 30 batter piles will support the south breakwater (see Figure 4.2 and Figure 4.3). The north breakwater will be installed between June and November (in water work window) as the first in-water element of ferry terminal construction. The exact year of this construction is dependent upon the date of construction of the first homes and it is estimated that it will be no earlier than 2018 nor later than 2020. The duration of the in water portion of the breakwater work in the first year of construction is estimated to be 3-5 months to drive the concrete sheets and to place the rock closure slope at the shore, described in the following section. No dewatering or excavation will be required for this work. Since the existing shore line is fully protected from wave exposure, no slope protection will be needed during construction. The dredging for the basin will occur during this same period or the following year. The south breakwater will be installed in a second phase or in the same year. The south breakwater location may be adjusted due to an existing underwater cable located in the "exclusion zone" as depicted in Figure 4.2. Alternatively, the underwater cable may be relocated and the south breakwater constructed as shown in Figure 4.2.

During construction of the breakwaters best management practices will include no fueling of equipment allowed on site for over water work, use of equipment that minimizes turbidity in the water, and require protective netting or equivalent devised to ensure no debris can fall into the water during the work.

Rock Slope Closure (Linkage between Breakwater and Shoreline): Two rock slopes will be constructed on each side of the ferry terminal at the shore end of the breakwaters (Figure 4.3 and Figure 4.4). The rock closure will consist of rip rap rock similar to the size (1-2 ton rock) and graduation of the existing rock slope and will be placed on top of the existing rock. The rock slope closures are needed to anchor and provide continuous wave protection of the breakwaters' connection at the shoreline. Each rock slope will require approximately 2,400 SF (0.06 ac) of fill in waters of the U.S. The rock will be constructed following construction of each breakwater with the use of an excavator positioned on the landward side of the shoreline revetment, as well as with the use of an excavator operated from a barge. No dewatering will be performed for this work. This work will be performed during the first year of construction during the installation of the concrete sheets. The rock slope closures will be constructed during the same year in which the adjacent breakwater is constructed.

Dredging: Construction of the ferry basin will require dredging approximately 6,000 CY of primarily sandy substrate to a depth of -14 feet (plus 2 feet of over-depth allowance, -16 feet total) in an area of approximately 0.55 acres (see Figure 4.4). Maintenance dredging may be required once the terminal is operational. The frequency and volume of dredging cannot be accurately predicted. The west shore of TI is not a high depositional environment and it is estimated that future dredging would be less than 2,000 CY performed at infrequent intervals (over 2 years). Permit applications for maintenance dredging will be submitted following construction of the ferry terminal.

Dredging will be conducted by a clamshell bucket operated from a barge-mounted crane. Dredged material will be placed onto an adjacent scow. Pending completion of sediment sampling, three locations for the disposal of dredged materials are under consideration, with selection to be determined upon completion of sediment sampling: beneficial re-use to raise surface elevations on Treasure Island; transport and beneficial re-use at Montezuma Wetlands, or beneficial re-use at Winter Island.

Pier (Abutment), Gangway and Float: The land access to the ferry slip includes:

- Pier: 13-feet-wide, 145-foot-long, with railing that may also have a canopy;
- Gangway: approximately 13-feet-wide, 90-feet-long, ADA- compliant, connects the pier and float; and
- Float: approximately 45-feet-wide, 115-feet-long, steel or concrete, anchored by six guide and fender piles. Mooring dolphins and/or fender walls will be included to protect the ferry from bumping against the float and other structures.

These features are shown in Figure 4.4. The float will have mooring fittings and access platforms on each side to allow two ferries to moor at the float at the same time.

Four 42-inch diameter steel fender and guide piles will be installed on the west side of the float Figure 4.4, and two 42-inch diameter steel guide piles will be installed on the east side of the float. The steel piles will be installed with the use of a vibratory hammer with an energy output of 6,000 ft-lb and a variable frequency between 0 and 1,400 vibrations per minute operated from a barge -mounted crane. The piles will be installed to a depth of embedment of 50-90 feet below the bay bottom, estimated, to be confirmed by geotechnical investigation currently in progress. The pier will be supported by 16 24-inch concrete pier foundation piles that will be installed with the use of a diesel powered impact hammer with approximately 100,000 ft-lb energy output operated from a barge-mounted crane to a depth of embedment of 50-90 feet below the bay bottom, estimated, to be confirmed by geotechnical investigation currently in progress.

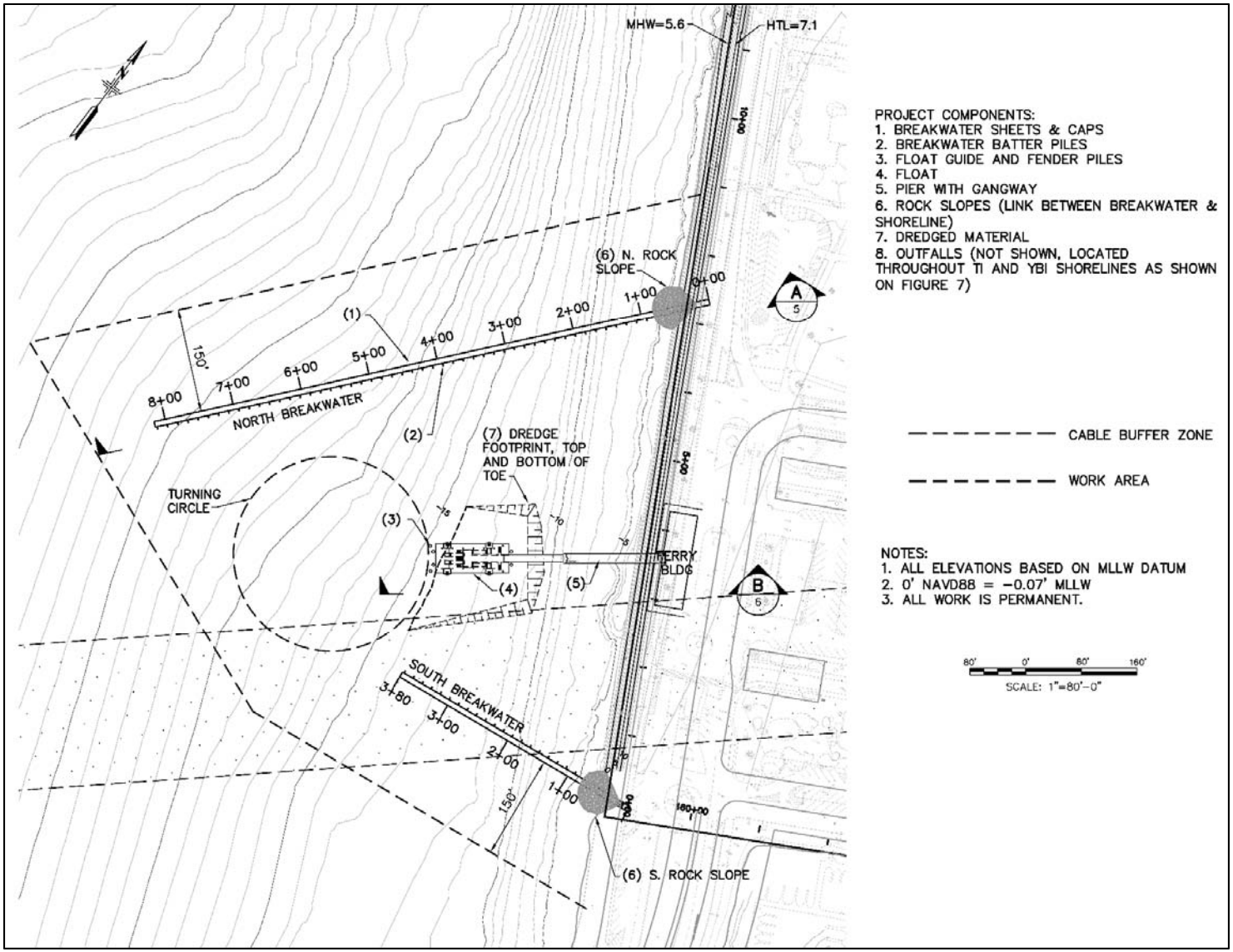


Figure 4.2: Project Elements and Pilings

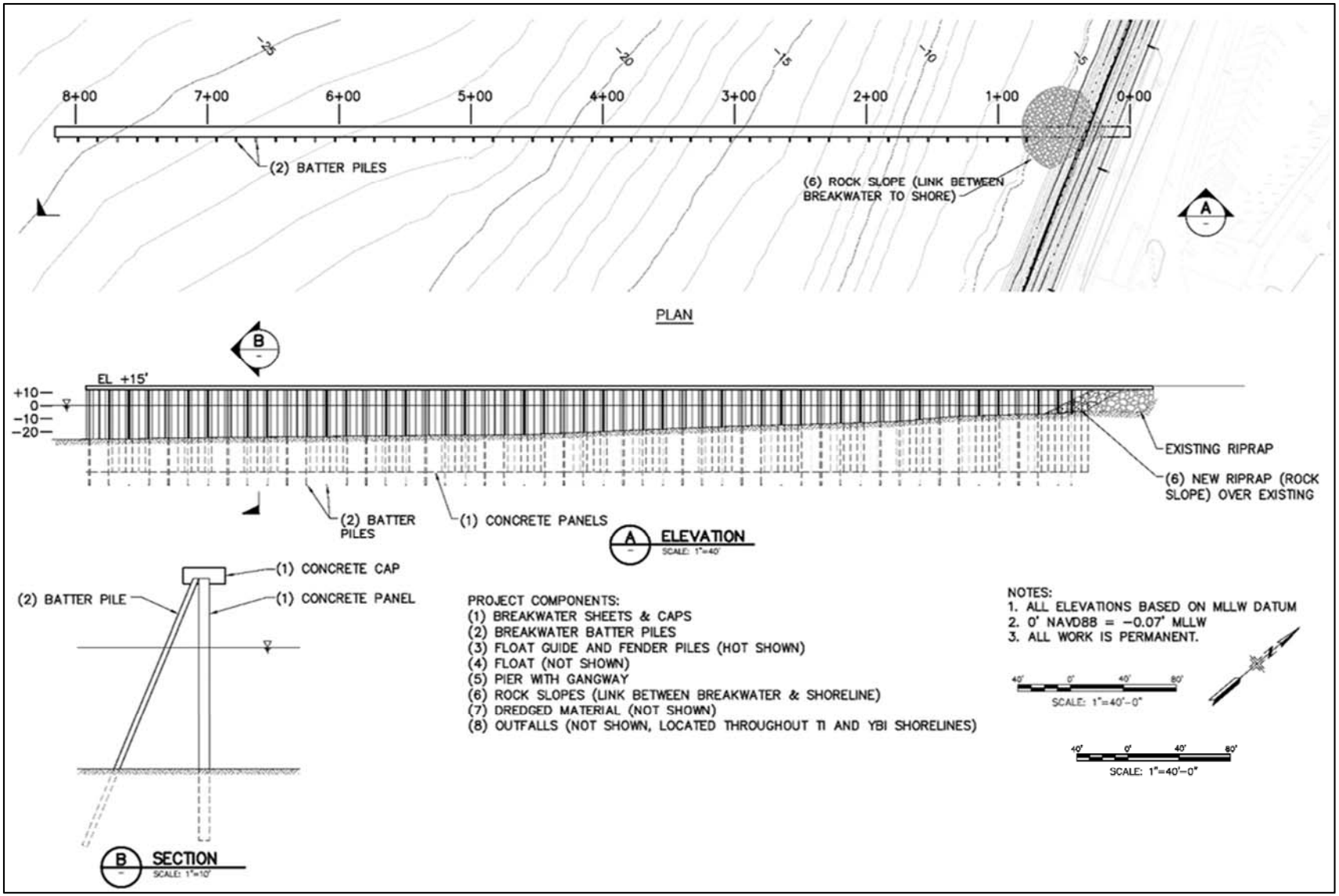


Figure 4.3: Breakwater Design

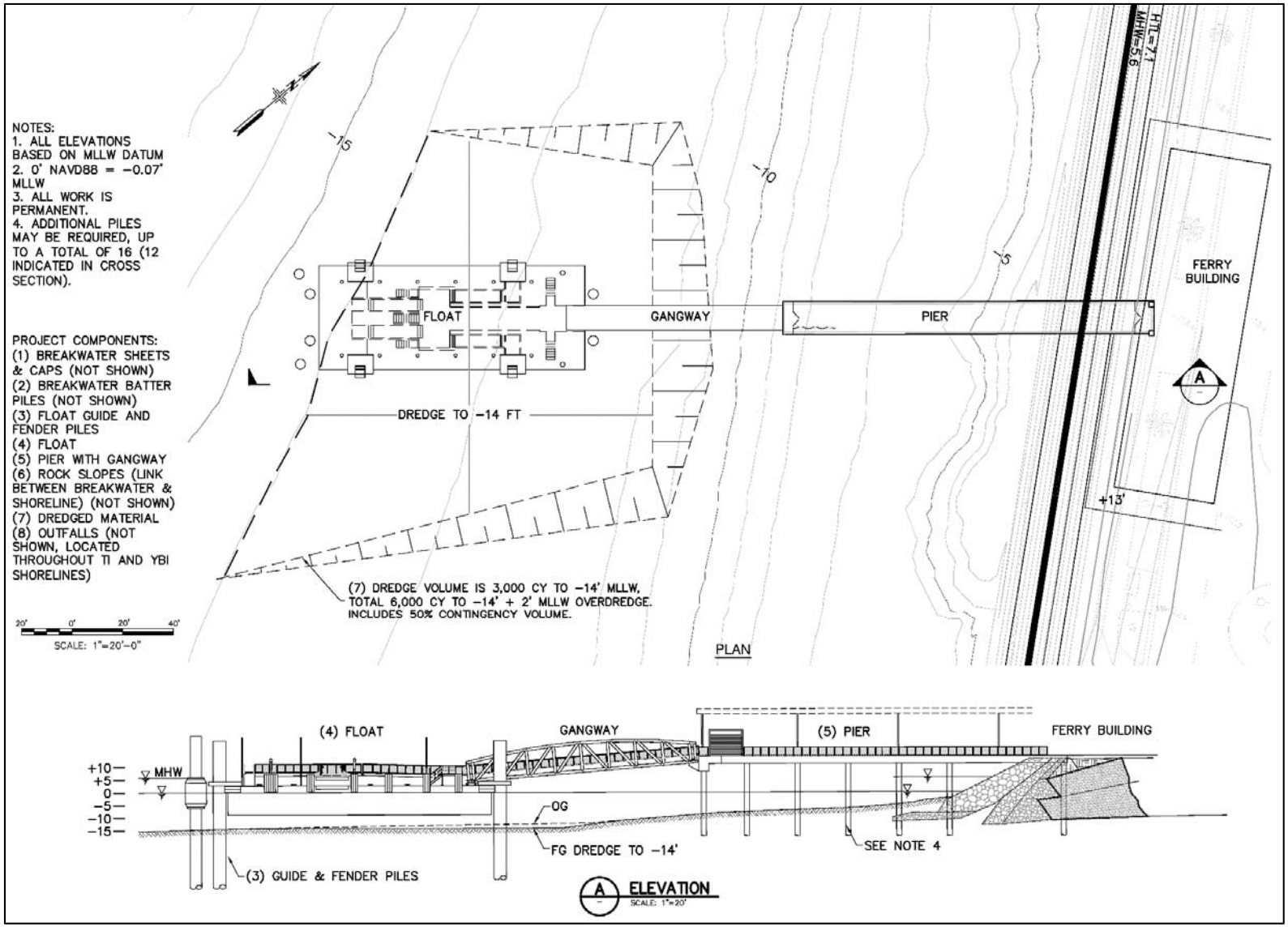


Figure 4.4: Access Pier, Gangway and Floating Dock

The installation of the pier, gangway and float for the ferry slip will occur in the second year of the construction of the ferry terminal. This work will occur during the same in water work window from June to November. The pier deck will be installed atop the piles described above of either formed in place concrete or coated steel. The work would be performed from smaller work skiffs or from scaffolding clamped to the installed piles. The float will be fabricated offsite and transported to the site with the use of a tug or similar tow vessel. The gangway would be fabricated off site and brought to the site on a barge. The gangway would then be placed on the pier and float by a barge mounted crane. The concrete sheet piles, batter, guide and fender and pier foundation piles will be manufactured off site and transported to the site on a barge that will stage delivery of materials within and just west of the ferry terminal location. Upon completion of this work, the ferry slip will be operational.

4.1.2. Outfall Improvements and Stormwater Management

Stormwater runoff from streets and paved areas on TI and YBI is currently discharged untreated directly to the Bay through 31 outfalls around the perimeter of TI and 32 outfalls from YBI. The existing stormwater system will be replaced with a new collection system, which will include gravity pipelines, force mains, lift stations, pump stations and the reconstruction of existing outfalls. Pre-discharge treatment will be provided by street planters and bioretention treatment planters. The stormwater management plan will be designed and constructed consistent with San Francisco Public Utility Commission (SFPUC) standards and regulations. Existing outfalls will be replaced, renovated or abandoned in place (see Figure 3.2, Figure 4.5, and Figure 4.6) during each of the four phases of construction (Table 4-1). A total of 14 outfalls will be replaced or renovated from existing outfalls on Treasure Island and Yerba Buena Island. The disturbance area surrounding each outfall will be isolated and dewatered with the installation of a coffer dam prior to earthwork. Each outfall will be constructed by temporarily excavating an approximately 850 SF area and removing approximately 50 CY of existing rock slope protection to allow installation of a precast or cast-in-place concrete headwall. After the headwall has been placed, the work area will be backfilled with the previously excavated rock riprap to conform to the existing slope. Approximately 30 CY of rock will be returned, 6 CY of concrete will be placed as the headwall, resulting in a net loss of fill of about 14 CY per outfall. Because final design of the stormwater treatment system and outfalls has not been completed, the maximum area of impact (discharge of fill material and excavation) for the outfalls is described in Table 4-2, to ensure that permits issued for the project are adequate to cover potential impact to waters of the U.S.

Existing rock shoreline protection at outfalls to be replaced or renovated will be excavated with the use of an excavator positioned on the shoreward side of the revetment. Excavated materials will be stockpiled in adjacent uplands for re-use or offsite disposal. The work areas surrounding the outfalls will be dewatered prior to construction with the use of sandbags or

water filled bladder-type cofferdams. Water would be removed with pumps on site returning the water to the bay.

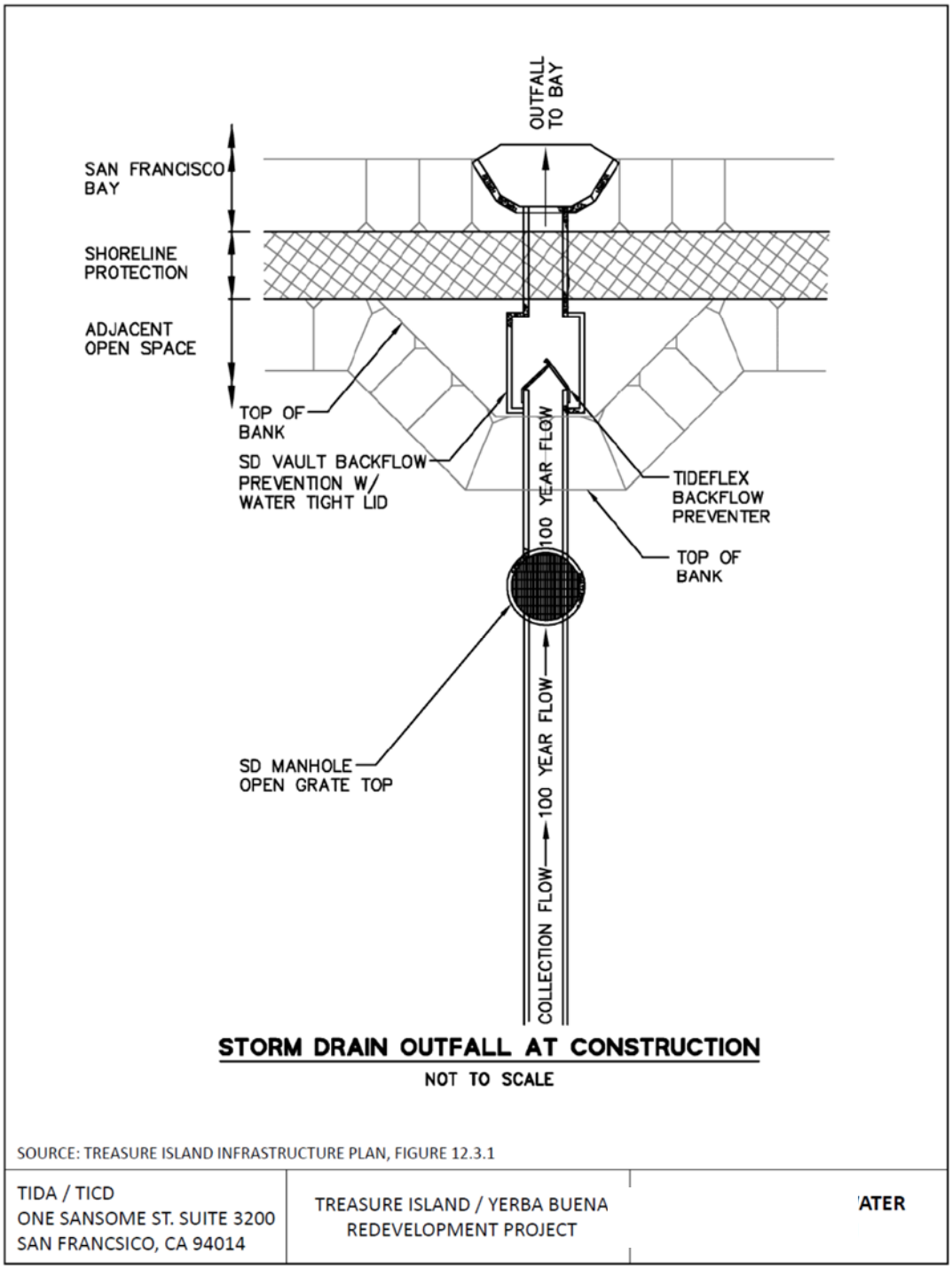
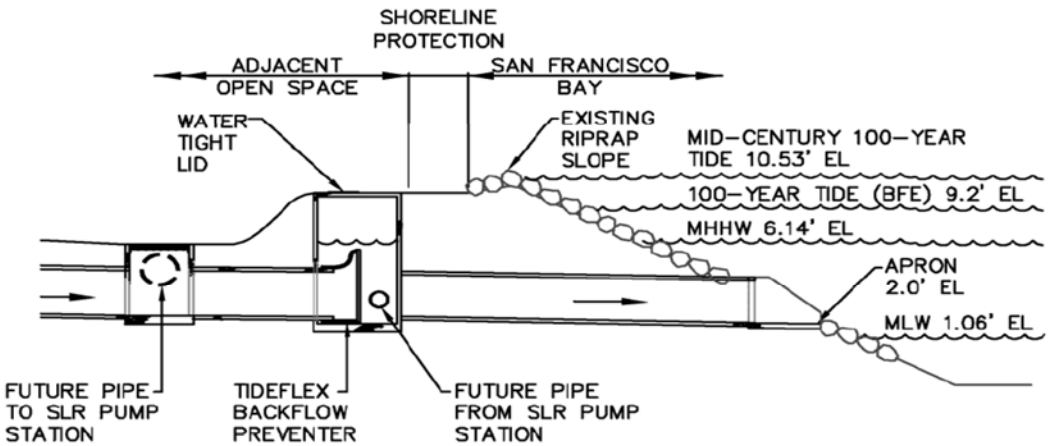


Figure 4.5: Stormwater Outfall Plan



STORM DRAIN OUTFALL – SECTION

NOT TO SCALE

PROJECTED TIDE ELEVATIONS WITH SEA LEVEL RISE

TIDE BENCHMARK	SLR	100-YR	MLW	MHHW
CURRENT	–	9.20'	1.06'	6.14'
MID-CENTURY (~2050)	16"	10.53'	2.39'	7.47'
3/4 CENTURY (~2075)	36"	12.20'	4.06'	9.14'
END CENTURY (~2100)	55"	13.78'	5.64'	10.72'

SOURCE: TREASURE ISLAND INFRASTRUCTURE PLAN, FIGURE 12.3.2

TIDA / TICD ONE SANSOME ST. SUITE 3200 SAN FRANCSICO, CA 94014	TREASURE ISLAND / YERBA BUENA REDEVELOPMENT PROJECT	

Figure 4.6: Stormwater Outfall Section

4.2. CONSERVATION (AVOIDANCE AND MINIMIZATION) MEASURES AND MONITORING

As part of construction activities and long-term operations and maintenance of the ferry terminal and additional stormwater discharges on Treasure Island associated with the proposed project, TIDA will employ a variety of conservation measures designed to avoid and minimize potential adverse effects to aquatic resources. The conservation measures provide increased protection for all aquatic resources within the estuary including listed salmonids and green sturgeon and their critical habitat, as well as the other listed species, critical habitat and Essential Fish Habitat within Central San Francisco Bay. These conservation measures (Best Management Practices – BMPs) and mitigation measures identified in the final project Environmental Impact Report (City and County of San Francisco, April 2011) and the final programmatic Environmental Impact Report for expansion of ferry transit service in the Bay Area (URS 2003) to reduce and avoid adverse impacts to fish and aquatic habitats, which are included specifically as part of the proposed action evaluated in this biological assessment, are provided below.

- Follow manufacture's recommendations on use, storage and disposal of chemical products used in construction;
- All refueling and maintenance activities shall occur at a dedicated area that is equipped with containment improvements and readily available spill control equipment and products. Overtopping construction equipment fuel gas tanks shall be avoided;
- During routine maintenance of construction equipment, properly contain and remove grease and oils;
- Properly dispose of discarded containers of fuels and other chemicals;
- Conduct an annual review of the Harbor Safety Plan;
- Update contingency plans and reviews of emergency response services. Review contingency plans, conduct drill exercises, and review emergency response agreements. Review emergency response equipment availability;
- Develop a program for training on fueling methods to minimize spills;
- Require review of new vessels to include technological features to minimize spills;
- Adopt applicable measures recommended by the Ferry Safety Plan;
- Adopt measures for construction to prevent, minimize, and clean up spills and leaks. Require containment measures for equipment that could potentially release fuels;
- Design new terminals to control storm water runoff and discharge;

- Conduct turbidity monitoring and management during ferry terminal construction and channel dredging. Use silt curtains or other techniques in accordance with DMMO recommendations for reducing dredging impacts. Dredge spoils will not be discharged into the Bay but will be placed on land for beneficial reuse;
- Disturbance of eelgrass beds and mudflats shall be avoided in the design of project features and routes. Site specific sidescan sonar surveys would be required prior to implementation of new routes or construction of new terminals to verify that eelgrass is not present. Avoid indirect impacts through use of silt curtains or methods to protect eel grass, mudflats, and native oysters from disturbance;
- Sound pressure monitoring and response during pile driving and sheet pile installation shall be conducted. Underwater sound pressure levels will be monitored during pile driving. A sound pressure threshold of 160 dB at 500 meters from the source was established in the EIR for triggering avoidance measures. If the threshold sound level is exceeded or avoidance response by fish is observed by an on-site marine biologist bubble curtains will be used to reduce sound/vibration to acceptable levels. In addition, the final ferry terminal design will use as few piles as possible, a vibratory hammer will be used for all steel piles, cushion blocks will be used between the hammer and pile, and pile driving will be restricted to the period June 1 to November 30 to avoid potential impacts to salmonids and Pacific herring;
- Consolidate ferry routes to leave as much undisturbed shallow open water habitat as possible;
- Construction and dredging activities in-water will be limited to only approved in-water work windows;
- Erosion and sediment control measures shall be implemented;
- Stormwater management and drainage pollutant prevention shall be implemented including pre-discharge treatment;
- Restriction of construction activities – activities in the lower intertidal and near subtidal zone shall be minimized to the maximum extent practicable;
- Seasonal limitations on in-water construction will be limited to the period from March 16 through November 30; and
- Eel grass bed surveys and avoidance will include periodic surveys and avoidance measures of impacts to eel grass beds.

5.0 EXISTING CONDITIONS

The action area within the Central San Francisco Bay provides habitat for juvenile and adult Chinook salmon, steelhead and green sturgeon and also supports managed fishery resource and EFH.

5.1. LISTED FISH SPECIES – LIFE HISTORY AND OCCURRENCE IN THE PROJECT ACTION AREA

5.1.1. Winter-run Chinook Salmon

Status

Winter-run Chinook salmon are listed as an endangered species under the FESA and CESA.

Winter-run Chinook salmon historically migrated into the upper tributaries of the Sacramento River for spawning and juvenile rearing. With the construction of Shasta and Keswick dams winter-run salmon no longer had access to historic spawning habitat within the upper watersheds. As a result of migration blockage spawning and juvenile rearing habitat for winter-run Chinook is limited to the mainstem Sacramento River downstream of Keswick Dam. During the mid-1960s adult winter-run Chinook salmon returns to the Sacramento River were relatively high (approximately 80,000 returning adults). However, the population declined substantially during the 1970s and 1980s. The population decline continued until 1991 when the adult winter-run Chinook salmon population returning to the Sacramento River was estimated to be less than 200 fish. As a result of the substantial decline in abundance the species was listed as endangered under FESA. During the mid- and late 1990s the numbers of adult winter-run salmon returning to the Sacramento River gradually increased and the trend of increasing abundance has continued to be present. Approximately 8200 adult winter-run salmon returned to the river to spawn in 2001. Approximately 7,400 adult winter-run Chinook salmon returned in 2002, 8,200 returned in 2003, 7,900 returned in 2004, 15,900 returned in 2005, 17,300 returned in 2006, 2,500 returned in 2007, 2,800 returned in 2008, and 4,500 returned in 2009. Approximately 1,600 winter-run adults returned in 2010 with approximately 800, 2,700, and 6,100 winter-run Chinook salmon returning to the Sacramento River in 2011-2013, respectively (CDFW GrandTab). As with other Chinook salmon stocks, NMFS is continuing to evaluate the status of the winter-run Chinook salmon population and the effectiveness of various management actions implemented within the Sacramento River, Delta, and ocean to provide improved protection and reduced mortality for winter-run salmon, in addition to providing enhanced habitat quality and availability for spawning in and juvenile rearing. NMFS has prepared a recovery plan for winter-run Chinook salmon.

Life History

Winter-run Chinook salmon are an anadromous species spending 1-3 years within the ocean before migrating upstream into the Sacramento River to spawn. The majority of adult winter-run

Chinook salmon returning to spawn are generally three-year-olds, however, the adult population also includes two-year-old and four-year-old Chinook salmon. Adult winter-run salmon migrate upstream through San Francisco Bay, Suisun Bay, and the Delta during the winter and early spring months with peak migration occurring during March (Moyle, 2002). Adult winter-run Chinook salmon migrate upstream within the Sacramento River with the majority of adults spawning in the reach upstream of Red Bluff. Winter-run Chinook salmon spawn within the mainstem of the Sacramento River in areas where gravel substrate, water temperatures, and water velocities are suitable. Spawning occurs during the spring and summer (mid-April through August; Moyle, 2002). Egg incubation continues through the fall months. Juvenile winter-run Chinook salmon rear within the Sacramento River throughout the year feeding primarily on aquatic insects. Juvenile winter-run salmon (smolts) migrate downstream through the lower reaches of the Sacramento River, Delta, Suisun Bay, and San Francisco Bay during the winter and early spring (December through May) as they migrate from the freshwater spawning and juvenile rearing areas into the coastal marine waters of the Pacific Ocean. The Sacramento River mainstem is the primary upstream and downstream migration corridor for winter-run Chinook salmon. Juvenile winter-run Chinook salmon may migrate from the Sacramento River into the lower reaches of channels within Suisun Marsh during their downstream migration. The migration timing of juvenile winter-run Chinook salmon varies within and among years in response to a variety of factors including increases in river flow and turbidity resulting from winter storms.

Factors Affecting Abundance

A variety of environmental and biological factors have been identified that affect the abundance, mortality, and population dynamics of winter-run Chinook salmon. One of the primary factors that has affected population abundance of winter-run Chinook salmon has been the loss of access to historic spawning and juvenile rearing habitat within the upper reaches of the Sacramento River and its tributaries as a result of the migration barrier caused by Shasta and Keswick dams. Operation of the Red Bluff Diversion Dam, which impedes adult upstream migration and increases vulnerability of juvenile winter-run Chinook salmon to predation mortality, has been identified as a factor affecting mortality within the river. In recent years, changes to Red Bluff Diversion Dam gate operations and construction of a new water diversion and fish screen have been made to provide improved access for upstream and downstream migrating winter-run Chinook salmon.

Water temperatures within the mainstem Sacramento River have also been identified as a factor affecting incubating eggs, holding adults, and growth and survival of juvenile winter-run Chinook salmon rearing in the upper Sacramento River. Modifications to Shasta Reservoir storage and operations and water temperature management have been implemented in recent years to improve water temperature conditions within the upper reaches of the Sacramento River. Juvenile winter-run Chinook salmon are also vulnerable to entrainment at a large number of unscreened water diversions located along the Sacramento River and within the Delta in addition to

entrainment and salvage mortality at the State Water Project (SWP) and Central Valley Project (CVP) export facilities. Changes in habitat quality and availability for spawning and juvenile rearing, exposure to contaminants and acid mine drainage, predation mortality by Sacramento pikeminnow, striped bass, and other predators, and competition and interactions with hatchery-produced Chinook salmon have all been identified as factors affecting winter-run Chinook salmon abundance. In addition, subadult and adult winter-run Chinook salmon are vulnerable to recreational and commercial fishing, ocean survival is affected by climatic and oceanographic conditions, and adults are vulnerable to predation mortality by marine mammals.

In recent years a number of changes have been made to improve the survival and habitat conditions for winter-run Chinook salmon. Modifications have been made to reservoir operations for instream flow and temperature management, modifications been made to Red Bluff diversion gate operations, and several large previously unscreened water diversions have been equipped with positive barrier fish screens. Changes to ocean salmon fishing regulations have also been made to improve the survival of adult winter-run Chinook salmon. Modifications to SWP and CVP export operations have also been made to improve the survival of juvenile winter-run Chinook salmon. These changes in management actions, in combination with favorable hydrologic and oceanographic conditions in recent years, are thought to have contributed to the trend of increasing abundance of adult winter-run Chinook salmon returning to the upper Sacramento River to spawn since the mid-1990s.

Presence in the Action Area and Vicinity

The majority of adult winter-run Chinook salmon migrate upstream in the mainstem Sacramento River, after having passed through Central Bay and Suisun Bay. The occurrence of adult winter-run Chinook salmon in Central Bay where proposed project activities would occur would be limited to the winter and early spring period of adult upstream migration. The majority of adult winter run salmon are thought to migrate upstream through the Bay-Delta during the period from about December to March or early April.

During their downstream migration, juveniles migrate through the Sacramento River, Suisun Bay, and Central Bay before entering coastal marine waters. The migration timing of juvenile winter-run Chinook salmon varies within and among years in response to a variety of factors, including increases in river flow and turbidity resulting from winter storms. Thus, potential presence of juvenile winter-run Chinook salmon in the vicinity of Treasure Island varies by season and among years within the period from December through May.

Since winter-run Chinook salmon do not spawn within Central Bay there is no probability that the proposed project would adversely affect winter-run Chinook salmon spawning, egg incubation, or early juvenile (fry) rearing stages.

5.1.2. Central Valley Spring-run Chinook Salmon

Status

Spring-run Chinook salmon are listed as a threatened species under FESA and CESA.

Spring-run Chinook salmon were historically widely distributed and abundant within the Sacramento and San Joaquin river systems (Yoshiyama *et al.* 1998). Spring-run Chinook salmon historically migrated upstream into the upper reaches of the mainstem rivers and tributaries for spawning and juvenile rearing. Construction of major dams and reservoirs on these river systems eliminated access to the upper reaches for spawning and juvenile rearing and completely eliminated the spring-run salmon population from the San Joaquin River system. Spring-run Chinook salmon abundance has declined substantially and the geographic distribution of the species within the Central Valley has also declined substantially. Spring-run spawning and juvenile rearing currently occurs on a consistent basis within only a small fraction of their previous geographic distribution, including populations inhabiting Deer, Mill, and Butte creeks, the mainstem Sacramento River, several other local tributaries on and intermittent basis, and the lower Feather River. Recent genetics studies have shown that spring-run like Chinook salmon returning to the lower Feather River are genetically similar to fall-run Chinook salmon. Hybridization between spring-run and fall-run Chinook salmon, particularly on the Feather River where both stocks are produced within the Feather River hatchery, is a factor affecting the status of the spring-run salmon population. NMFS has developed a recovery plan for Central Valley spring-run Chinook salmon.

Life History

Spring-run Chinook salmon are an anadromous species, spawning in freshwater and spending a portion of their life cycle within the Pacific Ocean. Adult spring-run Chinook salmon migrate upstream into the Sacramento River system during the spring months, but are sexually immature. Adult spring-run Chinook salmon hold in deep cold pools within the rivers and tributaries over the summer months prior to spawning. Spawning occurs during the late summer and early fall (late August through October) in areas characterized by suitable spawning gravels, water temperatures, and water velocities. Eggs incubate within the gravel nests (redds) emerging as fry during the late fall and winter. A portion of fry appear to migrate downstream soon after emerging where they rear within the lower river channels, and potentially within the Delta estuary, during winter and spring months. After emergence a portion of the spring-run Chinook salmon fry remain as residents in the creeks and rear for a period of approximately one year. The juvenile spring-run Chinook salmon that remain in the creeks migrate downstream as yearlings primarily during the late fall, winter and early spring with a peak yearling migration occurring in November (Hill and Weber, 1999). The downstream migration of both spring-run Chinook salmon fry and yearlings during the late fall and winter typically coincides with increased flow and turbidity associated with winter stormwater runoff.

Factors Affecting Abundance

A variety of environmental and biological factors have been identified that affect the abundance, mortality, and population dynamics of spring-run Chinook salmon. One of the primary factors that have affected population abundance of spring-run Chinook salmon has been the loss of access to historic spawning and juvenile rearing habitat within the upper reaches of the Sacramento River and its tributaries and San Joaquin River as a result of the migration barriers caused by construction of major dams and reservoirs. Operation of the Red Bluff Diversion Dam, which impedes adult upstream migration and increases the vulnerability of juvenile spring-run Chinook salmon to predation mortality, has been identified as a factor affecting mortality within the river. A new water diversion and positive barrier fish screen has recently been constructed to allow the Red Bluff Diversion Dam gates to remain open during most of the year, thereby improving migration conditions for juvenile and adult spring-run salmon and other migratory fish.

Water temperatures within the rivers and creeks have also been identified as a factor affecting incubating eggs, holding adults, and growth and survival of juvenile spring-run Chinook salmon. Juvenile spring-run Chinook salmon are also vulnerable to entrainment at a large number of unscreened water diversions located along the Sacramento River and within the Delta in addition to entrainment and salvage mortality at the SWP and CVP export facilities. Changes in habitat quality and availability for spawning and juvenile rearing, exposure to contaminants, predation mortality by Sacramento pikeminnow, striped bass, and other predators, and competition and interactions with hatchery-produced Chinook salmon have all been identified as factors affecting spring-run Chinook salmon abundance. In addition, subadult and adult spring-run Chinook salmon are vulnerable to recreational and commercial fishing, ocean survival is affected by climatic and oceanographic conditions, and adults are vulnerable to predation mortality by marine mammals.

In recent years a number of changes have been made to improve the survival and habitat conditions for spring-run Chinook salmon. Several large previously unscreened water diversions have been equipped with positive barrier fish screens. Changes to ocean salmon fishing regulations have been made to improve the survival of adult spring-run Chinook salmon. Modifications to SWP and CVP export operations have also been made to improve the survival of juvenile spring-run Chinook salmon. Improvements in fish passage facilities have also been made to improve migration and access to Butte Creek. These changes and management actions, in combination with favorable hydrologic and oceanographic conditions in recent years, are thought to have contributed to the trend of increasing abundance of adult spring-run Chinook salmon returning to spawn in Butte Creek and other habitats within the upper Sacramento River system in recent years.

Presence in the Action Area and Vicinity

The majority of adult spring-run Chinook salmon migrate upstream within the mainstem Sacramento River, after passing upstream through Central Bay and Suisun Bay. The occurrence of adult spring-run Chinook salmon within Central Bay in the vicinity of Treasure Island would be limited to the late winter and spring period (primarily March-May) of adult upstream migration. Juvenile spring-run Chinook salmon may migrate from the Sacramento River, including its tributaries, into the Delta and Central Bays during their downstream migration and also use the Bay-Delta estuary as a foraging area and migration pathway during the winter and early spring migration period. The occurrence of juvenile spring-run Chinook salmon in the areas adjacent to Treasure Island would be expected during late fall through spring (October-June), when water temperatures within the Bay-Delta would be suitable for juvenile spring-run Chinook salmon migration.

Since spring-run Chinook salmon do not spawn within Central Bay there is no probability that proposed activities on the islands would adversely affect spring-run Chinook salmon spawning, egg incubation, or early juvenile (fry) rearing stages.

5.1.3. Central Valley and Central California Coast Steelhead

Status

The Central Valley steelhead Distinct Population Segment (DPS) is listed as threatened under the ESA but is not listed under CESA. NMFS designated critical habitat for Central Valley steelhead on September 2, 2005 which includes Central Bay where proposed project activities would occur. Central California Coast steelhead are also listed as a threatened species under the ESA but is not listed under CESA.

Central Valley steelhead are produced in rivers and streams tributary to the Delta located upstream of the Carquinez Straight. Central California Coast are produced in rivers and stream located downstream of the Carquinez Straight. Both Central Valley and Central California Coast steelhead use Central Bay as a migratory corridor.

Steelhead historically were distributed throughout the Sacramento and San Joaquin Rivers. Steelhead were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick Dams) south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alterations from numerous water diversion projects) and in both east and west-side Sacramento River tributaries (Yoshiyama *et al.* 1998). The present distribution has been greatly reduced (McEwan and Jackson 1996). Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). The California Advisory Committee on Salmon and

Steelhead (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles currently. Dams block access to 80 percent of historic habitat and access to all historical spawning habitat for about 38 percent of historical populations (Lindley *et al.* 2006).

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley.

Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). Juvenile salmonid monitoring has been conducted at Oakdale and/or Caswell on the Stanislaus River since 1995, and is used to estimate abundance of out-migrating steelhead/rainbow trout to the San Joaquin River (USFWS 2008). Steelhead smolts also have been occasionally observed at Caswell State Park and Oakdale (USFWS 2000). Zimmerman *et al.* (2008) and NMFS (2009) have documented Central Valley steelhead in the Stanislaus, Tuolumne and Merced rivers based on otolith microchemistry. Incidental catches and observations of juvenile steelhead have occurred on the Tuolumne and Merced rivers, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005).

Life History and Habitat Requirements

Steelhead can be divided into two life history types, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Stream-maturing steelhead enter freshwater in a sexually immature condition and require several months to mature and spawn, whereas ocean-maturing steelhead enter freshwater with well-developed gonads and spawn shortly after river entry. These two life history types are more commonly referred to by their season of freshwater entry (*i.e.,* summer [stream-maturing] and winter [ocean-maturing] steelhead). Steelhead within the Action Area are considered winter-run steelhead (ocean-maturing), based on their state of sexual maturity at the time of river entry and the duration of their spawning migration (NMFS 2009). Central Valley steelhead generally spawn in small streams where cool, well-oxygenated water is

available year-round (Hallock *et al.* 1961). Upstream migration can extend all year, however most fish migrate from December through March. The Bay-Delta serves as a migration corridor for immigrating adult steelhead and emigrating juvenile steelhead. The Bay-Delta also supports juvenile steelhead rearing prior to emigration to the Pacific Ocean.

Winter steelhead generally leave the ocean from August through April, and spawn between December and May (Busby *et al.* 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Typically, adult steelhead moving into the Sacramento River Basin begin to enter the Bay-Delta during mid- to late-summer, and subsequently enter the Sacramento River system from July to early September. Kelts, post-spawning adults, are typically seen later in the spring following spawning. Adult steelhead entering the San Joaquin River Basin appear to have a later spawning run than Sacramento River Basin steelhead, entering the basin in late October through December, indicating presence in the Delta beginning a few weeks earlier (NMFS 2009).

Unlike Pacific salmon, steelhead are capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Nickelson *et al.* 1992, Busby *et al.* 1996). Most steelhead spawning takes place from late December through April, with peaks from January through March (Hallock *et al.* 1961). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity, and may spawn in intermittent streams as well (Everest 1973, Barnhart 1986).

The length of the incubation period for steelhead eggs is dependent on water temperature, dissolved oxygen (DO) concentration, and substrate composition. In late spring and following yolk sac absorption, fry emerge from the gravel and actively begin feeding in shallow water along stream banks (Nickelson *et al.* 1992).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools although young-of-the-year also are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive rearing steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Some older juveniles move downstream to rear in large tributaries and mainstem rivers (Nickelson *et al.* 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey upon emerging fry.

Steelhead generally spend one to two years in freshwater before emigrating downstream. During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat.

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Based on fish facility salvage data, most juvenile steelhead move through the Bay-Delta from November through June, with the peak salvage occurring during February, March, and April (Reclamation 2008). Juvenile steelhead have been collected in the Chipps Island trawls from October through July (NMFS 2009).

Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Bay-Delta for rearing and as a migration corridor to the ocean. Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Bay-Delta as rearing areas for short periods prior to their final emigration to the sea. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 mm (fork length). Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall.

Hatchery-produced steelhead juveniles typically occur at Chipps Island from January through March, with a peak occurrence during February and March. The difference in the timing of emigration between wild and hatchery-reared steelhead smolts is largely due to the timing of hatchery releases. Based on the small numbers of emigrating steelhead that are captured in the lower Sacramento River, it appears that most hatchery steelhead smolts pass Knights Landing soon after they are released from Coleman Hatchery in January, and pass rapidly through the Delta to Chipps Island, although some linger for several months. Naturally produced fish mainly pass Knights Landing in April and May (Williams 2006).

Factors Affecting Abundance

One of the primary factors that have affected population abundance of Central Valley steelhead has been the loss of access to historic spawning and juvenile rearing habitat within the upper reaches of the Sacramento River and its tributaries and San Joaquin River as a result of the migration barriers caused by construction of major dams and reservoirs. Operation of the Red Bluff Diversion Dam, which impedes adult upstream migration and increases the vulnerability of juvenile steelhead to predation mortality, has been identified as a factor affecting mortality within the river. A new water diversion and positive barrier fish screen has recently been constructed to allow the Red Bluff Diversion Dam gates to remain open during most of the year, thereby improving migration conditions for juvenile and adult steelhead and other migratory fish.

Water temperatures within the rivers and creeks have also been identified as a factor affecting incubating eggs, holding adults, and growth and survival of juvenile steelhead. Juvenile spring-run Chinook salmon are also vulnerable to entrainment at a large number of unscreened water diversions located along the Sacramento River and within the Delta in addition to entrainment and salvage mortality at the SWP and CVP export facilities. Changes in habitat quality and availability for spawning and juvenile rearing, exposure to contaminants, hybridization with

hatchery-produced steelhead, predation mortality by Sacramento pikeminnow, striped bass, and other predators, and competition and interactions with hatchery-produced Chinook salmon and steelhead have all been identified as factors affecting steelhead abundance. In addition, subadult and adult steelhead are vulnerable to recreational fishing in the rivers, ocean survival is affected by climatic and oceanographic conditions, and adults are vulnerable to predation mortality by marine mammals.

In recent years a number of changes have been made to improve the survival and habitat conditions for steelhead. Several large previously unscreened water diversions have been equipped with positive barrier fish screens. Modifications to SWP and CVP export operations have also been made to improve the survival of juvenile steelhead. Improvements in fish passage facilities have also been made to improve migration and access to upstream habitat.

Presence in the Action Area and Vicinity

The majority of steelhead migrate upstream within the mainstem Sacramento River, after passing upstream through Central Bay and Suisun Bay. The occurrence of adult steelhead within areas adjacent to Treasure Island would be limited to the late winter and spring period (primarily March-May) of adult upstream migration. Juvenile steelhead may migrate from the Sacramento River, including its tributaries and other Central Valley rivers and streams, into the Delta and Suisun and Central Bays during their downstream migration and also use the Bay-Delta as a foraging area and migration pathway during the winter and early spring migration period. The occurrence of juvenile steelhead in Central Bay in the vicinity to Treasure Island would be expected during late fall through spring (October-June), when water temperatures within the Bay-Delta would be suitable for juvenile steelhead migration.

Since steelhead do not spawn within Central Bay there is no probability that activities adjacent to Treasure Island would adversely affect steelhead spawning, egg incubation, or juvenile rearing stages.

5.1.4. Southern Distinct Population Segment of North American Green Sturgeon

Status

The North American green sturgeon has been separated into two DPSs: (1) the northern DPS (all populations north of and including the Eel River) and (2) the southern DPS (coastal and Central Valley populations south of the Eel River, which includes the Proposed Project Action Area). Green sturgeon in the southern DPS are listed as Threatened under the Federal ESA but are not listed under CESA. NMFS has not prepared a recovery plan for the southern DPS of North American green sturgeon. However, NMFS did prepare a status review update, which includes recovery criteria. NMFS has designated critical habitat for green sturgeon, which includes Central Bay and the areas adjacent to Treasure Island.

Historic and current green sturgeon spawning occurs in the upper Sacramento River (Adams *et al.* 2002, Beamesderfer *et al.* 2004). Currently, upstream migrations of sturgeon are halted by Keswick Dam on the mainstem of the Sacramento River. Spawning on the Feather River is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river below Oroville Dam. Spawning in the San Joaquin River system has not been recorded historically or observed recently.

The size of the population of green sturgeon is difficult to estimate due to a lack of data specific for this fish. Entrainment numbers at the SWP and CVP pumping facilities in the south Delta provide a relative indicator of abundance of juvenile green sturgeon and have been consistently lower than their levels in the mid -1970s (SWP) and the mid-1980s (CVP). Prior to 1986, the SWP (1968 -2001) averaged 732 green sturgeon salvaged per year, which dropped to 47 per year after 1986. The CVP (1980-2001) showed similar declines in its salvage rate for green sturgeon, 889 per year prior to 1986 and 32 per year after 1986.

Limited information about population abundance for the southern DPS of North American green sturgeon comes from incidental captures by a CDFW sturgeon tagging program to monitor white sturgeon (NMFS 2009). CDFW (2002) estimated that green sturgeon abundance ranged from 175 to more than 8,000 adults between 1954 and 2001 with an annual average of 1,509 adults; however, CDFW does not consider these estimates reliable. Over the last two decades, the green sturgeon population in the Sacramento River is believed to have declined, with less than 50 spawning green sturgeon being sighted annually in the best spawning habitat along the middle section of the Sacramento River (NMFS 2009).

Life History and Habitat Requirements

As anadromous fish, green sturgeon rely on riverine, estuarine, and marine habitats. Freshwater habitat of green sturgeon of the southern DPS varies in function, depending on location in the Sacramento River. Spawning areas currently are limited to accessible reaches of the Sacramento River upstream of Hamilton City and downstream of Keswick Dam (CDFW 2002). Green sturgeon prefer low gradient reaches or off-channel sloughs and coves with large cobble, deep and cool pools, and turbulent flows (CDFW 2002; Moyle 2002).

There is relatively little known about green sturgeon migratory requirements of adults and juveniles, particularly for those that spawn in the Sacramento River (The Natural Conservancy *et al.* 2008). Adult green sturgeon begin their upstream spawning migrations into the San Francisco Bay in March, migrate upstream primarily along the western edge of the Delta into the lower Sacramento River and reach Knights Landing during April. Spawning occurs between March and July, when temperatures are between 45° and 57°F (Reclamation 2008). Peak spawning is believed to occur between April and June. Green sturgeon spawn upstream of Hamilton City, and possibly to Keswick (CDFW 2002). After spawning in the Sacramento River, adult green sturgeon move downstream into holding habitats in the lower river or further into the Delta, returning through the San Francisco Bay to the ocean during late fall or winter.

During flood years, the Yolo Bypass serves as an important migration corridor for Southern DPS adults on their upstream and downstream migrations to and from the Sacramento River (NMFS 2009). Although feeding by green sturgeon within the bypass has not been documented, the bypass provides a high macroinvertebrate forage base that may support feeding.

Eggs hatch in about 8 days at 55°F (Reclamation 2008). Newly hatched green sturgeon are strongly oriented to the river bottom and exhibit nocturnal activity patterns. After six days, larvae begin their nocturnal downstream migrational movements. Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFW 2002). Two-week-old green sturgeon have been captured at RBDD, and three-week-old green sturgeon have been captured further downstream at the GCID facility. Green sturgeon larvae and post larvae are present in the North Delta (and lower Sacramento River) between May and October, primarily in June and July (CDFW 2002).

Juveniles spend one to two years in freshwater before migrating into the ocean (Nakamoto *et al.* 1995), leaving the Sacramento River prior to September. Juvenile green sturgeon have been observed in the Bay-Delta through the San Francisco Bay including Rio Vista to Chipps Island, Sacramento Deepwater Ship Channel, Montezuma Slough, and Suisun Bay, during all months of the year. Juveniles have also been observed during the summer in shallow shoals 3.3 to 9.8 feet deep (water depth) in the lower San Joaquin River, and year-round in the South Delta at the SWP and CVP fish facilities (CDFW 2002).

Juveniles use the Bay-Delta areas to forage and rear until they gain the osmoregulatory capacity to tolerate higher salinity concentrations. Stomach contents from adult and juvenile green sturgeon captured in the Delta and San Pablo and Suisun bays point to the importance of habitat that supports shrimp, mollusks, isopods, clams, annelid worms, amphipods, unidentified crabs, and small fish (Reclamation 2008).

Suitable water temperatures for juvenile green sturgeon are reportedly below about 75°F (24°C). Suitable salinity levels range from freshwater (less than 3 parts per thousand [ppt]) for larvae and early juveniles in upstream riverine habitats to brackish water and full strength saltwater (33 ppt) for juvenile, subadult, and adult green sturgeon (including Suisun, San Pablo and Central San Francisco Bays).

Factors Affecting Abundance

Juvenile green sturgeon are vulnerable to entrainment at water diversions and water control structures within the Bay-Delta. Juvenile and adult green sturgeon may be trapped behind the barriers, preventing movement particularly during their installation and operation, but are removed from the channels each winter. The Delta Cross-Channel (DCC) is an additional flow operation related barrier to adult migration. Other potential migration barriers include the Sutter Bypass and the Fremont Weir. The Fremont Weir is at the upstream end of Yolo Bypass. Green sturgeon enter the Yolo Bypass while it is inundated with floodwaters. When floodwaters

recede the green sturgeon become trapped behind the Fremont Weir, which impedes upstream migration. Trapped sturgeon are susceptible to heavy fishing pressure (legal and illegal).

Juvenile green sturgeon may be vulnerable to unscreened agricultural diversions within the Delta, although most of the over 2,000 diversions are considered to be too small to pose a risk to juvenile and larger sturgeon (Reclamation 2008). There is no evidence to indicate that sturgeon are entrained by the operations of the Contra Costa Canal (CCC) (Reclamation 2008). Juvenile green sturgeon are entrained regularly at the CVP and SWP salvage facilities. Subadult and adult green sturgeon are also known to be entrained at the CVP and SWP pumping facilities in the Delta. Adult-sized sturgeon have been collected from the SWP Clifton Court Forebay.

Green sturgeon forage on benthic macroinvertebrates, shrimp, and other prey in close proximity to the bottom. Historical reclamation of wetlands and islands as well as channelization has reduced and degraded suitable in- and off-channel rearing habitat for green sturgeon. Channelization in the Delta has reduced the amount of subtidal and intertidal habitat used for foraging by juvenile, subadult and adult green sturgeon. These habitats are considered important for growth during the juvenile, coastal migrant, and adult life stages. Further, the channelization and hardening of levees with the use of riprap has reduced in- and off-channel intertidal and subtidal rearing habitat as well as seasonal inundation of floodplains. The resulting changes to river hydraulics, riparian cover, and geomorphology affect important ecosystem functions. Due to juvenile and adult green sturgeon feeding primarily on benthic organisms such as clams and shrimp, habitat related impacts of reclamation, channelization, and riprapping are expected to contribute to reductions in food source availability and altered predator abundance. The impacts of channelization and riprapping are thought to affect all life stages of green sturgeon, as they are all dependent on the freshwater and estuarine food webs within the rivers and the Bay-Delta.

Contamination of the Sacramento River has increased since the 1970s due to the application of rice pesticides and other contaminants for agricultural uses as well as the discharge of a number of point- and non-point source contaminants associated with municipal and industrial development, agriculture, and natural sources (USFWS 1996). Studies on white sturgeon in estuaries indicate that the bioaccumulation of pesticides and other contaminants adversely affects growth and reproductive development and may result in decreased reproductive success (Fairey *et al.* 1997; Foster *et al.* 2001a; Foster *et al.* 2001b; Kruse and Scarnecchia, 2002; Feist *et al.*, 2005; Greenfield *et al.* 2005, *all* as cited in 73 FR 52084). Green sturgeon are believed to experience similar effects from contaminants (70 FR 17386; 73 FR 52084). Toxicants found in the Delta and throughout the watershed, including methylmercury, endocrine disruptors, and pyrethroids are also known to affect juvenile green sturgeon. While other toxicants persist in the San Francisco Bay-Delta, the near- and long-term independent and synergistic effects of these chemicals on green sturgeon are unknown.

Green sturgeon are long-lived (60 to 70+ years) fish that make repeated spawning migrations through the Bay-Delta. They continually ingest contaminated forage prey, especially benthic filter feeders, and are exposed to contaminants in the water column during spawning migrations. As a result, they can suffer from bioaccumulation of contaminants that originate from urban stormwater runoff (which may contain petroleum products, heavy metals, and various organic solvents), agricultural derived runoff (i.e., pesticides, herbicides, fertilizers, and animal wastes), and wastewater treatment plants (metals, pharmaceuticals, personal care products, organic compounds). Green sturgeon growth, fecundity, and egg size are likely negatively affected by contaminants found within the Bay-Delta like selenium and mercury (Linville 2006). Selenium can also cause larvae to have increased skeletal deformities and cause mortality associated with maternal bioaccumulation.

Exposure to seasonally elevated water temperatures in the Delta and throughout the watershed has been identified as a factor affecting habitat quality for various life stages of green sturgeon. Water temperatures above about 68° F (20° C) are reportedly lethal to green sturgeon embryos, and temperatures below about 52° F (11° C) or above about 66° F (19° C) reportedly lead to reduced growth (Cech *et al.* 2000 as cited in Adams *et al.* 2002). It is possible that low levels of dissolved oxygen (DO) in the subtidal and intertidal Delta habitats and the SDWSC can cause chronic stress in young green sturgeon (Lankford *et al.* 2003).

Invasive species have affected green sturgeon through changes in the Delta food web and ultimately their diet. Increased availability of new (nonnative) benthic species (e.g., Asian Overbite Clam) has increased foraging opportunities. One consequence has been an increase in bioaccumulation of contaminants. The Overbite Clam, due to its high filtration efficiency, accumulates selenium in high concentrations and loses it slowly (Luoma and Presser 2000). Dietary selenium in high concentrations could adversely affect green sturgeon survival, activity and growth.

Nonnative fish such as striped bass, largemouth and smallmouth bass, and centrarchids may prey upon juvenile green sturgeon. No quantitative data are available, however, on the magnitude of the contribution of predation mortality on the population dynamics of green sturgeon.

Green sturgeon can be caught incidentally by recreational fishermen targeting white sturgeon, potentially resulting in hooking mortality. Illegal harvest of green sturgeon is known to occur in the Sacramento River, particularly in areas where sturgeon have become concentrated, as well as throughout the Bay-Delta. Currently, there are no hatchery operations for green sturgeon.

Presence of Green Sturgeon in the Action Area

Although the Sacramento River watershed is the identified migration route and spawning area for green sturgeon, both adult and juvenile green sturgeon are known to occur within Central Bay. Juveniles have been captured in the vicinity of Santa Clara Shoals, Brannan Island State

Recreational Area and in the channels of the south Delta (Moyle *et al.* 1992, Beamesderfer *et al.* 2004). Both adult and juvenile green sturgeon may use the Bay-Delta as a migratory, resting, or rearing habitat. Occurrence in Central Bay could occur in any month, as juveniles may reside there during their first few years of growth. Adults are likely to be present in the winter and early spring as they move through the Bay-Delta towards their spawning grounds in the upper Sacramento River watershed. Following spawning, the fish will pass through the Bay-Delta again on their way back to the ocean, but the duration and timing of this event is not well understood in the Sacramento River system.

5.2. ESSENTIAL FISH HABITAT

The Action Area of Central San Francisco Bay is included in the listing of Essential Fish Habitat for a variety of pelagic, groundfish, and salmon species covered by the Coastal Pelagic Fish Management Plan (FMP), the Pacific Groundfish FMP, and the Pacific Coast Salmon FMP developed by the Pacific Fishery Management Council under the requirements of the Magnuson-Stevens Act. Table 5-1 lists those fish species covered by these plans identified as utilizing the Action Area, along with the life stage and relative occurrence within the Action Area as determined from CDFW unpublished Bay Study midwater trawl and otter trawl data for the years 1980-2012.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NMFS on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. The proposed Treasure Island project is located within the Central Bay region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMP and for starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) in Amendment 11 to the Pacific Coast Groundfish FMP.

The Pacific Fishery Management Council (PFMC) has identified and described EFH. Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes not only the watersheds of the Sacramento and San Joaquin River basins but also the Delta, Suisun Bay and San Francisco Bay. Sacramento River winter-run, Central Valley spring-run, and Central Valley fall/late fall-run Chinook salmon are species managed under the Salmon Plan that occur in Central San Francisco Bay, the Delta, Suisun Bay, and lower Sacramento River. Factors limiting salmon populations in the Bay-Delta include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps), loss of

fish into unscreened agricultural diversions, predation by introduced species, and reduction in the quality and quantity of rearing habitat due to channelization (e.g., riprapping), pollution, loss of access to upstream habitat and changes in instream flows and seasonal water temperature. Factors affecting salmon populations in San Francisco Bay include heavy industrialization within its watershed and discharge of wastewater effluents into the bay. Loss of vital wetland habitat along the fringes of the bay reduce rearing habitat and diminish the functional processes that wetlands provide for the bay ecosystem.

Table 5-1: Managed Fish Species under the Magnuson-Stevens Act in Central Bay

Fisheries Management Plan	Species, Common Name	Species, Scientific Name	Life Stage*	Central Bay
Coastal Pelagic	Northern anchovy	*Engraulis mordax*	J, A	Abundant
	Jack mackerel	*Trachurus symmetricus*	E,L	Present
	Pacific sardine	*Sardinops sagax*	J, A	Present
Pacific Groundfish	English sole	*Parophrys vetulus*	J, A	Abundant
	Sand sole	*Psettichthys melanostictus*	L, J, A	Present
	Curlfin sole	*Pleuronichthys decurrens*	J	Rare
	Pacific sanddab	*Citharichthys sordidus*	E, L, J, A	Present
	Starry flounder	*Platichthys stellatus*	J, A	Present
	Lingcod	*Ophiodon elongates*	J, A	Present
	Brown rockfish	*Sebastes auriculatus*	J	Present
	Pacific whiting (hake)	*Merluccius productus*	E,L	Present
	Kelp greenling	*Hexagrammos decagrammus*	J, A	Present
	Leopard shark	*Triakis semifasciata*	J, A	Present
	Spiny dogfish	*Squalus acanthias*	J, A	Present
	Skates	*Raja* ssp.	J, A	Present
	Soupfin shark	*Galeorhinus galeus*	J, A	Rare
	Bocaccio	*Sebastes paucispinis*	J	Rare
	Cabezon	*Scorpaenichthys marmoratus*	J	Present
Pacific Coast Salmon	Chinook salmon	*Oncorhynchus tshawytscha*	J, A	Seasonally Present
	Coho salmon	*Oncorhynchus kisutch*	J, A	Historically Present, Current Occurrence unknown

Table Information Sources: Pacific Fishery Management Council. 2011. Groundfish - http://www.pcouncil.org/groundfish/background/; Salmon- http://www.pcouncil.org/salmon/background/; Coastal Pelagic- http://www.pcouncil.org/coastal-pelagic-species/background-information/. Accessed April 20, 2011. CDFW Bay Study unpublished mid water trawl and otter trawl data 1980 – 2012.

NOTES: A = Adult; J = Juvenile; L = Larvae; E = Egg

5.2.1. Pacific Salmon

General life history information for Central Valley Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in Sections 5.1.1 and 5.1.2.

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December while adult Central Valley late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April. Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles or along the edges of fast runs.

Egg incubation occurs from October through March, with fry emergence typically from late January through April. Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters. The remaining fry hide in the gravel or calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Bay-Delta estuary from mid-March through mid-June. As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore. Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Bay-Delta estuary before entry into the ocean. Whether entering the Bay-Delta estuary as fry or juveniles, Central Valley Chinook salmon depend on passage through Central San Francisco Bay for access to the ocean.

5.2.2. Starry Flounder

The starry flounder is a flatfish found throughout the eastern Pacific Ocean, from the Santa Ynez River in California to the Bering and Chukchi Seas in Alaska, and eastwards to Bathurst inlet in Arctic Canada. Adults are found in marine waters. Spawning takes place during the fall and winter months in marine and estuarine waters. The adults spawn in shallow coastal waters near river mouths and sloughs, and the juveniles are found almost exclusively in estuaries. The juveniles often migrate up freshwater rivers, but are estuarine dependent. Eggs are broadcast spawned and the buoyant eggs drift with wind and tidal currents. Juveniles gradually settle to the bottom after undergoing metamorphosis from a pelagic larva to a demersal juvenile by the end of April. Juveniles feed mainly on small crustaceans, barnacle larvae, cladocerans, clams and dipteran larvae. Juveniles are extremely dependent on the condition of the estuary for their health. Polluted estuaries and wetlands decrease the survival rate for juvenile starry flounder. Juvenile starry flounder also have a tendency to accumulate many of the anthropogenic contaminants found in the environment.

5.2.3. English Sole

The English sole is a flatfish found from Mexico to Alaska. It is abundant in the San Francisco Bay estuary system. Adults are found in nearshore environments. English sole generally spawn during late fall to early spring at depths of 50 to 70 meters over soft mud bottoms. Eggs are initially buoyant, and then begin to sink just prior to hatching. Incubation may last only a few days to a week depending on temperature. Newly hatched larvae are bilaterally symmetrical and float near the surface. Wind and tidal currents carry the larvae into bays and estuaries, including Central Bay, where the larvae undergo metamorphosis into the demersal juvenile. The young depend heavily on the intertidal areas, estuaries, and shallow near-shore waters for food and shelter. Juvenile English sole primarily feed on small crustaceans (*i.e.* copepods and amphipods) and on polychaete worms in these rearing areas. Polluted estuaries and wetlands decrease the survival rate for juvenile English soles. The juveniles also have a tendency to accumulate many of the contaminants found in t heir environment and this exposure manifests itself as tumors, sores, and reproductive failures.

5.3. ENVIRONMENTAL SETTING

The Central San Francisco Bay, Suisun Bay, and the western Delta are habitat to a diverse assemblage of marine and estuarine organisms (Hanson *et al.* 2004, URS 2003). The biological environment is a complex community of plants and animals inhabiting the saltwater, estuarine (brackish-water), and freshwater habitats within the Bay-Delta Estuary. The Bay-Delta is a complex estuarine ecosystem, a transition zone between inland sources of freshwater and saltwater from the ocean. Along the salinity gradient extending from the Golden Gate upstream into the Delta, the species composition of the aquatic community changes dramatically, although the basic functional relationships among organisms (e.g., predator-prey, etc.) remain similar throughout the system.

The primary energy input to the system is solar radiation, which is used, along with nutrients, by the primary producers (phytoplankton, are a food resource for many zooplankton as well as some larval and adult fish; vascular plants, and macroalgae are also important primary producers) to convert inorganic carbon and nutrients to organic matter through photosynthesis. Zooplankton (e.g., copepods, cladocerans, *mysid* shrimp) prey on the phytoplankton. The vascular plants and macroalgae are grazed on and also produce detritus, which is decomposed by microbes and consumed by detritivores (e.g., polychaete worms, amphipods, cladocerans, and a diverse group of other fish and macroinvertebrates). The primary consumers are in turn preyed upon by secondary consumers, consisting mainly of a variety of invertebrates (polychaete worms, snails, copepods, *mysid* shrimp, bay shrimp, and crabs) and fishes (green and white sturgeon, delta and longfin smelt, northern anchovy, Pacific herring, topsmelt, white croaker, flatfish, gobies, sculpin, shad, juvenile Chinook salmon, and a variety of other resident and migratory fish species). These in turn are preyed on by top consumers, such as fish (striped bass, largemouth bass, catfish, sturgeon, halibut, sharks, and

rays), marine mammals, birds, and man. The role of a species in the food web may be different at different lifestages, or it may utilize various levels of the food web simultaneously.

Fish species may utilize the estuary for any or all of their life history stages. They may have planktonic, epibenthic (demersal) and pelagic (open water) life histories. The majority of fish species inhabiting the estuary have planktonic larval stages; as plankton they feed on zooplankton and in some cases phytoplankton. Many of these species forage on plankton during the larval and early juvenile lifestages, and then as juveniles and adults become more selective predators and feed on large invertebrates and fish. Demersal fish such as sturgeon, flatfish, gobies, sculpin, and croaker, are planktivorous as larvae but begin to feed on epibenthic invertebrates and fish as juveniles. Many smaller fish including smelt, silversides, northern anchovy and Pacific herring are planktivorous throughout their lives.

Some estuarine fish do not rely on plankton as a major food source at any lifestage. The live-bearing surfperch, for example, predominantly feed on epibenthic invertebrates, such as mollusks, crustaceans, and polychaetes throughout their life. Sharks and some skates and rays feed on benthic and epibenthic invertebrates by shoveling through the substrate, and also feed on fish and large invertebrates in the water column. Many freshwater fish prey primarily on benthic and drifting insect larvae and crustaceans, because zooplankton abundance is low in the swifter flowing freshwater sloughs and rivers.

The abundance and species composition of fish inhabiting the estuary vary in response to salinity gradients (Baxter *et al.* 1999). The most abundant taxa inhabiting the high-salinity areas of Central Bay include the schooling pelagic forage fish such as northern anchovy, Pacific herring, topsmelt, jacksmelt, and true smelt (whitebait, surf smelt, and night smelt). Other members of Central Bay fish community include flatfish, rockfish, surfperch, gobies, and sharks. In the low-salinity areas of Suisun Bay and the western Delta the most abundant taxa include striped bass, prickly sculpin, Pacific staghorn sculpin, threadfin shad, yellowfin goby, and starry flounder. Anadromous fish species such as Chinook salmon, steelhead, American shad, striped bass, and sturgeon utilize the entire estuarine system as a migration corridor and foraging habitat.

Factors affecting the abundance and geographic distribution of fish within the estuary include water velocities, substrate, salinity gradients, water temperature, and food availability. Many of the fish that inhabit the estuary reside in coastal marine waters, entering the estuary on a seasonal basis for foraging or reproduction. The seasonal cycles of fish abundance vary in response to migration patterns, reproductive cycles, foraging patterns, and environmental conditions occurring both within the estuary and coastal marine waters.

5.3.1. Aquatic Habitats - Central Bay

The aquatic habitats of Central Bay are characteristic of marine inshore environments. These habitats include intertidal and subtidal zones, as well as offshore open water subtidal areas.

Intertidal Zone

The intertidal zone comprises that area along the margin of Central Bay that is submerged at high tide and exposed at the lowest tide. Shoreline development within many areas along the margins of Central Bay have extensively influenced intertidal habitat. Concrete rubble, riprap, shoreline stabilization materials, and pilings and wharves are common in many areas. The intertidal zone is primarily composed of mud substrate (mudflats) in areas where low current velocities and low or reduced turbulence occur with coarser sand and gravel substrate within the intertidal areas characterized by higher current velocities and increased turbulence. Mud and sand substrate within the intertidal zone provide habitat for benthic organisms, particularly polychaete worms, crustaceans such as amphipods, and clams. Rocky substrate and large outcroppings, including pilings and riprap, provide areas for attachment of sessile organisms such as barnacles, mussels, and algae. Various species of shore crabs also inhabit intertidal rocky areas. Fish commonly associated with intertidal areas include sculpin, surfperch, gobies, topsmelt, and flatfish. In Central Bay, Pacific herring spawn in intertidal habitats having hard substrate.

Subtidal Zone

The subtidal zone extends offshore from the lowest area exposed by the tide (MLLW). In this zone water currents, water depth, and texture of the substrate are important factors influencing the species composition, abundance, and distribution of benthic infauna and bottom dwellers. Benthic infauna and epibenthic invertebrates inhabiting the subtidal zone include polychaete worms, crustaceans, clams, and mussels. Polychaete worms are generally the most diverse taxa, with amphipods the dominant crustacean, and several species of clams widely distributed within Central Bay subtidal habitat. Bay shrimp, represented by the genus *Crangon* is a common macroinvertebrate occupying the subtidal zone. The subtidal zone also provides habitat for a variety of fish. Some of the more common fish found in subtidal areas include surfperch, flounder, sole, halibut, Pacific herring, striped bass, topsmelt, sculpin, sharks, and rays. Around many of the areas of Central Bay the waterfront consists of wharfs and pilings. Wharfs provide shade and shelter to fish and bottom-dwelling invertebrates, and untreated pilings provide additional cover and habitat for mussels, barnacles, hydroids, crabs, amphipods, and borrowing worms. These organisms provide an additional food source for resident fish including rockfish, surfperch, and flatfish.

Open water (Pelagic) and Deep Subtidal Zone

The offshore open waters and deep subtidal habitat begins at a depth of about 30 feet, reflecting differences in light penetration and other variables. A variety of planktonic and free swimming organisms utilize this habitat. Plankton consist of phytoplankton (plants), zooplankton (typical small invertebrates that float or drift passively with the prevailing current), and ichthyoplankton (fish eggs and larvae). Actively swimming organisms (nekton) include juvenile and adult fish, crustaceans such as bay shrimp and crabs, and marine mammals.

Macroinvertebrates that inhabit the deep water areas of Central Bay include several species of bay shrimp, juvenile Dungeness crab, and several other crab species. The open water areas of Central San Francisco Bay provide habitat for a variety of marine and anadromous fish species. Fish inhabiting the deep water habitat include northern anchovy, Pacific herring, Chinook salmon, steelhead, green and white sturgeon, and other migratory fish, several species of flatfish including California halibut, surfperch, striped bass, and rockfish. Water depth, current velocity, salinity and temperature, and substrate are important factors affecting habitat use within the deep water areas of Central Bay by fish and macroinvertebrates.

5.4. AQUATIC HABITAT FUNCTION AND USE

Fish, shrimp, and crabs use habitats within the Bay-Delta Estuary for a number of functions including, but not limited to:

- Adult and juvenile foraging;
- Spawning;
- Egg incubation and larval development;
- Juvenile nursery areas; and
- Migratory corridors.

Species use of aquatic habitats for any of these functions may vary in response to a suite of factors, and many of these factors may vary daily, seasonally, and annually. Primary factors affecting species composition, geographic distribution, and use of habitat within the estuary are varied but include:

- Salinity gradients;
- Variation in water temperature;
- Variation in water depth;
- Variation in water velocity;
- Substrate; and
- Availability of foraging and cover habitat (e.g., pilings, rock outcroppings, submerged aquatic vegetation, and riprap).

The Bay-Delta environment is dynamic, varying in response to factors such as the magnitude of freshwater inflow from the Sacramento and San Joaquin river systems and other tributaries, wind and tidally driven current patterns, seasonal variation in water temperatures, and a variety of other physical and biological processes. The habitat use and functions of areas within

the Bay-Delta vary in response to these physical factors as well as to differences in life history characteristics and habitat requirements for the wide variety of fish and macroinvertebrates. In short, at any given site, the conditions which may affect habitat use by a species may vary and use of habitats at the site by a species, at any particular life history stage may vary. It may, therefore, be possible to generally predict whether a species is likely to utilize a site, and to generally predict what that use might be under a given set of circumstances. In an ecosystem where conditions such as freshwater flow may change rapidly and somewhat unpredictably, it is difficult to predict the distribution and abundance of aquatic species with precision. The CDFW and USFWS provide some general insight into how many aquatic species may respond to some of the varying habitat and environmental conditions.

Baxter *et al.* (1999) categorized the fish, shrimp, and crabs inhabiting the Bay-Delta Estuary based on three different life history strategies, including the following:

- Species that reside in the estuary year-round;
- Species that seasonally inhabit the estuary, typically as foraging, spawning, or juvenile nursery habitat; and
- Anadromous or migratory species that move through the estuary during passage to or from freshwater and coastal marine habitats. The vast majority of anadromous fish species, including Chinook salmon, steelhead, striped bass, American shad, and green and white sturgeon, migrate through the northern portion of San Francisco Bay (e.g., Central Bay, San Pablo Bay, and Suisun Bay) during their upstream and downstream migrations into the Sacramento and San Joaquin river systems. A substantially smaller proportion of anadromous fish populations migrate into the South Bay.

Among the seasonal inhabitants, many species use the Bay-Delta Estuary as a spawning area and/or juvenile nursery habitat on either an obligatory or nonobligatory basis (Baxter *et al.* 1999). For obligate species, reproduction and rearing of juveniles occurs almost exclusively within a bay or estuarine environment**.** Non-obligate species may or may not inhabit the estuary during any given year. The occurrence of non-obligate species varies substantially from one year to the next within the Bay-Delta Estuary. These species are typically found in the more marine areas of the estuary and are generally not abundant upstream within Suisun Bay or the marsh. Opportunistic species use the Bay-Delta Estuary as an extension of their habitat based on the suitability of environmental conditions. Many species that inhabit coastal marine waters, such as northern anchovy, may opportunistically move into the estuary when conditions are favorable for reproduction, juvenile rearing, and foraging. Baxter *et al.* (1999) notes that several freshwater or low-saline species, such as white catfish and threadfin shad*,* may opportunistically use habitats within Suisun Bay, San Pablo Bay or Central Bay during periods of high freshwater outflow from the river systems that result in lower salinity and more suitable habitat conditions for these species further downstream within the system.

Anadromous species such as Chinook salmon, steelhead, and green sturgeon spawn within freshwater portions of rivers and creeks tributary to the Bay-Delta Estuary. Juvenile rearing habitat for these species is also primarily within the freshwater or low-saline portions of the system. Juvenile Chinook salmon and steelhead emigrate from freshwater habitats and move downstream through the estuary, which is used primarily as a migratory corridor and short-term foraging habitat, as they move into coastal waters for rearing. Adult Chinook salmon and steelhead subsequently migrate back upstream to spawn, again using the Bay–Delta Estuary as a migratory corridor. Delta smelt inhabit the freshwater and brackish waters of the Delta and Suisun Bay throughout their lifecycles and do not occur in Central San Francisco Bay in the vicinity of Treasure Island. Longfin smelt spawn primarily in the freshwater reach of the lower Sacramento River but juveniles and adults inhabit more saline areas of western Suisun Bay, San Pablo Bay, San Francisco Bay, and near-shore coastal waters including Central Bay in the vicinity of Treasure Island.

5.5. HABITATS OF PARTICULAR CONCERN (HAPC)

The two primary habitats of particular concern are eel grass beds and native Olympia oyster beds. These habitats are limited to the higher salinity areas within Central Bay.

Eel grass beds occur within the low intertidal and shallow subtidal zones of Central Bay. Within Central Bay localized, shallow water subtidal areas have been colonized by eelgrass that serves important habitat and ecological functions within the estuary. As a consequence of the relatively high turbidity and suspended sediment concentrations naturally occurring within the Bay-Delta estuary light penetration (photic zone) limits the occurrence of submerged aquatic vegetation to relatively small, intertidal and shallow subtidal areas within Central Bay. The distribution of eel grass beds in Central Bay (Hanson *et al.* 2004) shows relatively small areas colonized in Richardson Bay, adjacent to the Alameda shoreline south of the Bay Bridge, near the Emeryville Marina, and in several locations along the Richmond shoreline. Eel grass beds have been identified along the eastern shoreline of Treasure Island and a smaller bed has been detected on the north side of the island (Merkel & Associates 2004). These eel grass beds provide critical habitat for Pacific herring spawning and habitat for a number of fish and macroinvertebrates. No eel grass beds were identified in the vicinity of the proposed Treasure Island ferry terminal although eel grass beds are known to be present at other locations along the northern and eastern Treasure Island shoreline, and on the northern shoreline of Yerba Buena Island in Clipper Cove (Merkel & Associates 2008, 2010).

Native California oysters historically inhabited the intertidal and shallow subtidal areas within Central Bay. As a result of pollution, degradation of water quality, loss of habitat, oyster drill predation, and other factors the oyster population was virtually eliminated from Central Bay. Efforts are currently underway to restore oysters to Central Bay in several areas such as adjacent to the Marin Rod and Gun Club. Native oyster populations are making a significant recovery in Central San Francisco Bay in recent years. Applied Marine Sciences (AMS 2009)

reported observing native oysters throughout the lower intertidal zone of Treasure and Yerba Buena Islands with the highest densities and greatest individual sizes observed along the west and north shorelines. Efforts to restore the native oyster population to the Bay are continuing.

6.0 EFFECTS ANALYSIS

6.1. EFFECTS FROM EXPOSURE TO TURBIDITY AND SUSPENDED SEDIMENTS

Construction activity, including dredging, in addition to ferry movement as part of routine operations has the potential to result in temporary localized increases in turbidity and suspended sediment concentrations. Localized increases in turbidity following disturbance are expected to disperse and settle to the bottom within hours. There is concern that this sediment plume could adversely affect the health and behavior of adult and juvenile Chinook salmon and steelhead and other fish exposed to the elevated suspended sediment concentrations. This section discusses the possible effects of suspended sediments from construction and routine operations of the proposed Treasure Island ferry terminal on fish for use as a foundation for assessing the potential for adverse effects to protected fish species and EFH. Although specific data are not available for construction and operations of the ferry terminal on Treasure Island, the data available from the scientific literature, including tests and studies done on a variety of fish species from the Bay-Delta Estuary and elsewhere, have shown that species and lifestages vary substantially in sensitivity to suspended sediment exposure. Table 6-1 provides an example data summary from a variety of studies illustrating the range of responses of various species and lifestages of fish and macroinvertebrates to exposure to suspended sediments. Hanson *et al.* (2004), Anchor Environmental (2003), and Rich (2010) provide more comprehensive reviews of information on the dose-response of fish and macroinvertebrates to suspended sediments, which forms part of the scientific and technical foundation used in this assessment. This section presents a general literature review on the effects of suspended sediment concentrations on behavior and health of various fish species, with special reference given to protected fish species found in Central Bay. Studies relevant to this issue were reviewed regardless of whether the species studied occurs in the estuary because data on Bay-Delta species are limited. This approach was taken in an effort to fully define the range of potential effects from construction and operation of the proposed ferry terminal as well as stormwater discharges on Treasure and Yerba Buena islands. Information on the response of various species to suspended sediment exposure, including extrapolations from species similar to those inhabiting Central Bay, form part of the foundation for this assessment.

Exposure to excessive suspended sediment concentrations could lead to physiological stresses such as clogged gills, eroded gill and epithelial tissues, impaired foraging activity and feeding success, and altered movement and migration patterns of juvenile and adult fish (Clarke and Wilber 2000; Davis and Hidu 1969; Grant and Thorpe 1991; Minello *et. al.* 1987; Newcombe and Jensen 1996; Newcombe and MacDonald 1991). Exposure of fish to elevated suspended sediment concentrations (SSCs) could result in behavioral avoidance and exclusion from otherwise suitable habitat; disrupt movement and migration patterns; reduce feeding rates and growth; result in sublethal and lethal physiological stress, habitat degradation, or delayed hatching; and, under severe circumstances, could result in mortality (see Newcombe and

Jensen 1996; Clarke and Wilber 2000). The response of fish to suspended sediments varies among species and lifestages as a function of suspended particle size, particle shape (angularity), water velocities, SSCs, water temperature, depressed dissolved oxygen concentrations, contaminants, and exposure duration (O'Connor 1991; Sherk 1971; Newcombe and Jensen 1996). Results of these and other investigations were used in assessing the effects of suspended sediment concentrations on the behavior and physiology of protected fish inhabiting Central Bay and EFH within the estuary.

Table 6-1: Response of Marine Species to a Certain Concentration Level of Suspended Sediments

Concentration (mg/l)	Exposure Duration (hours)	Fish Response	Reference
1,000	1	10% Mortality	Sherk *et al.,* 1974
2,310	24	10% Mortality	Sherk *et al.,* 1975
4,710	24	50% Mortality	Sherk *et al.,* 1975
9,600	24	90% Mortality	Sherk *et al.,* 1975
2,310	24	10% Mortality	O'Conner *et al.,* 1976
4,710	24	50% Mortality	O'Conner *et al.,* 1976
9,600	24	90% Mortality	O'Conner *et al.,* 1976
2,310	1	10% Mortality	Sherk *et al.,*1975
4,710	1	50% Mortality	Sherk *et al.,* 1975
9,600	1	90% Mortality	Sherk *et al.,* 1974
4,300	3	5% Mortality	Peddicord 1980
500-2,500	1,008	No Mortality	USFWS 1970
39,300	24	No Mortality	Newcomb and Flagg 1983
82,400	6	60% Mortality	Newcomb and Flagg 1983
207,000	1	100% Mortality	Newcomb and Flagg 1983
11,000	4	50% Mortality	Ross 1982
29,000-33,000	96	50% Mortality	Servizi and Gordon 1990
1,900	20	No Effect	Peddicord 1980
9,200	8	5% Mortality	McFarland and Peddicord 1980
300	21	No Effect	Mackin 1961
100	12	No Effect	Davis and Hidu 1969
200	12	No Effect	Davis and Hidu 1969
300	12	No Effect	Davis and Hidu 1969
400	12	10% Mortality	Davis and Hidu 1969
117,000	240	80% Mortality	Peddicord *et al.,* 1975
<1,000	240	10% Mortality	Peddicord *et al.,* 1975
<70,000	240	No Mortality	Peddicord *et al.,* 1975
1,000	2	Epidermis Damage	Boehlert1984
200	2	No Effect	Cardwell *et al.,* 1976
500	2	No Effect	Cardwell et al., 1976
600	2	No Effect	Cardwell et al., 1976
800	2	50% Mortality	Cardwell et al., 1976
1,000	1	50% Mortality	Cardwell et al., 1976
1,200	2	Abnormal Shell Development	Cardwell et al., 1976
1,800	2	No Effect	Cardwell et al., 1976

Concentration (mg/l)	Exposure Duration (hours)	Fish Response	Reference
5,300	2	No Effect	Cardwell et al., 1976
5,510	2	50% Mortality	Cardwell et al., 1976
7,000	2	50% Mortality	Cardwell et al., 1976
1,000	96	10% Mortality	McFarland and Peddicord 1980
3,600	96	20% Mortality	McFarland and Peddicord 1980
6,000	96	50% Mortality	McFarland and Peddicord 1980
200	0.5	Reduced Feeding	Breitberg 1988
485	1	50% Mortality	Morgan *et al.,* 1975
500	3	Increased Mortality	Auld and Schubel 1978
500	0.5	Reduced Feeding	Breitberg 1988
1,200	10	10% Mortality	Wakeman *et al.,* 1975
1,200	24	No Mortality	Bechmer *et al.*, 1975
1,200	96	No Mortality	Bechmer *et al.*, 1975
6,800	24	No Mortality	Bechmer *et al.*, 1975
6,800	96	No Mortality	Bechmer *et al.*, 1975
20,000	24	No Mortality	Bechmer *et al.*, 1975
20,000	96	No Mortality	Bechmer *et al.*, 1975
45,000	24	40% Mortality	Bechmer *et al.*, 1975
45,000	96	60% Mortality	Bechmer *et al.*, 1975
1,200	96	No Mortality	Bechmer *et al.*, 1975
6,000	24	No Mortality	Bechmer *et al.*, 1975
22,000	24	40% Mortality	Bechmer *et al.*, 1975
2,000	24	100% Mortality	Bechmer *et al.*, 1975

Specific objectives of the analysis included:

- Review scientific information to evaluate the potential stresses and effects of sand mining on protected and managed fish from exposure to increased suspended sediment concentrations and turbidity;
- Assess the potential for sand mining activity to adversely affect the fish species, habitat availability or quality, or habitat function for various lifestages; and
- Review and discuss biological effects of suspended sediment exposure and turbidity including:
    - Lethal effects: result in mortality of individuals, cause population reductions, or damage the capacity and function of habitats to support various species and lifestages;

- Sub-lethal effects: result in reduced growth rate, physiological stress, reduced health or condition of individuals, gill or skin abrasion; and
- Behavioral effects: create a barrier or impediment to migration, reduction in feeding rates, avoidance response, abandonment of otherwise suitable habitat, and alter predator-prey relationships.

Five ways in which high concentrations of suspended sediment that could adversely affect protected and managed fish species have been identified from the literature (Wood and Armitage 1997):

- Reduced rates of growth and reduced tolerance to disease or resulting in mortality. Lethal concentrations of suspended sediments primarily kill by clogging gill rakers and gill filaments (identified in Wood Armitage (1997); from Burton 1985);
- Reductions in the suitability of spawning habitat and affecting the development of eggs, larvae and juveniles; these stages typically are the most susceptible to suspended sediment, much more so than adult fish (identified from Chapman 1988, Moring 1982);
- Modification of migration patterns of fish (identified from Alabaster and Lloyd 1982);
- Reduction in the abundance of food available to fish due to a reduction in light penetration and prey capture (feeding activity), reduced primary production, and a reduction of habitat available to insectivore and other benthic macroinvertebrates prey items (identified from Burton 1985; Doeg and Koehn 1994; Gray and Ward 1982); and
- Effects on the efficiency of prey detection and foraging success, particularly in the case of visual feeders (Burton 1985).

Investigations conducted to evaluate the effects of suspended sediments on various species and lifestages of fish are summarized in Hanson *et al.* (2004) and include:

- Reviews of the effects of suspended sediment on fish inhabiting San Francisco Bay (O'Connor 1991; USFWS 1970) and more comprehensive reviews by Peddicord and McFarland (1978), Peddicord (1976), Sherk (1971), O'Connor *et al.* (1976), Newcombe and MacDonald (1991), Muncy *et al.* (1979), Newcombe and Jensen (1996), Wilber and Clarke (2001); and
- Individual laboratory investigations of various responses of fish to increased suspended sediment concentration. These include studies by Breitburg (1988) on the effects of increased suspended sediment concentration on prey consumption by striped bass larvae, Bisson and Bilby (1982) on the avoidance of suspended sediments by juvenile coho salmon, Wildish *et al.* (1977) on avoidance of suspended sediments by adult Pacific

herring, and Whitman *et al.* (1982) on the influence of suspended sediments on the homing behavior of adult Chinook salmon.

Effects Assessment

Exposure to elevated SSCs associated with dredging and construction of the ferry terminal is expected to be localized to the area immediately adjacent to the ferry terminal site and temporary. Dredging will remove approximately 6,000 CY of primarily sandy substrate to a depth of -16 feet affecting an area of approximately 0.55 acres. In addition, maintenance dredging is expected to be required at infrequent intervals (over 2 years) to remove less than 2,000 CY of substrate. All dredging activity will be limited to designated work windows to avoid sensitive time periods for migratory salmonids and other species. The substrate will be tested for chemical contaminants prior to dredging. Dredge spoils will not be discharged to the Bay but will be used on land for beneficial re-use. Turbidity monitoring will be performed during dredging and other in-water construction activity and if levels exceed prescribed water quality limits established by the Regional Water Quality Control Board silt curtains or other methods will be used to reduce the potential for increased turbidity and SSCs to affect fish and sensitive intertidal and subtidal habitats. Based on these avoidance and minimization measures, the area and volume of dredged material, and the use of upland disposal the duration and magnitude of exposure to increased SSCs is not expected to result in lethal conditions for fish or other aquatic resources. Localized elevated SSCs are expected during dredging activity that would be expected to result in sublethal responses such as avoidance of the construction area by sensitive species. Species such as longfin smelt and green sturgeon may be present in the area during dredging and would be expected to avoid the immediate area where dredging disturbance is occurring. Once dredging is complete turbidity and SSCs are expected to diminish to background levels within a period of hours and sensitive fish will return to the area.

Increased exposure to elevated SSCs and turbidity may also occur associated with storm drain discharges. The proposed renovated storm drain system will be designed to provide pre-discharge treatment to reduce sediment and contaminant discharges. In addition, soil erosion prevention methods (e.g., filter berms, silt fences, straw bales, storm drain inlet protection and vegetated buffers, etc.) will be employed to further reduce sediment transport and discharge from the storm drainage system. During periods of stormwater runoff ambient turbidity and SSCs in the central Bay are typically elevated which further reduces the incremental difference between background ambient conditions and storm drain discharges.

The area within the ferry terminal complex where ferry landings would occur will be dredged to a depth of -16 feet. Ferry draft is expected to be approximately 8 feet. The deeper water in the vicinity of the terminal is expected to be sufficient to minimize sediment resuspension by prop wash from the ferries. Although the ferry movement within the terminal area is expected to entrain air bubbles into the upper water column that would dissipate within minutes there would be temporary localized increased turbidity resulting from entrained air. Sensitive fish

would be expected to avoid localized areas where ferry disturbance occurs as a result of prop wash.

Based on the conditions that are anticipated to occur during construction and operation of the ferry terminal and proposed storm drainage discharge system it was concluded that the proposed project may affect (behavioral avoidance), but is not likely to adversely affect, protected fish, sensitive habitat such as eel grass beds or native oysters, or EFH. Potential effects will be limited to the immediate area where dredging activity is occurring and will be temporary, lasting only as long as dredging and construction activity occurs.

6.2. EFFECTS FROM CONTAMINANTS AND TOXICITY

There is the potential that exposure to contaminants associated with construction activity or stormwater discharges could affect the health of larval, juvenile, and adult protected and managed fish species due to exposure to increased levels of contaminants re-suspended with the fine sediments. There is also the potential exposure to chemical contaminants during construction and operation of the ferry terminal as a result of accidental spill. An extensive body of scientific information is available on the effects of exposure for various species and lifestages of protected fish and other aquatic species to contaminant concentrations. The proposed project has been designed and will be operated using BMPs and other mitigation measures (Section 4.2) specifically intended to avoid and minimize adverse exposure to contaminants. Sediment samples will be analyzed for chemical contaminants prior to dredging and construction of the ferry terminal. Spill prevention and cleanup provisions have been integrated into the project both during construction and as part of long-term routine maintenance and operations (e.g., refueling) of ferries. In addition, pre-discharge treatment of stormwater is included as part of the proposed project design. As a result of these measures and monitoring exposure of fish and sensitive aquatic habitats to chemical contaminants, toxicity effects are not expected.

Based on these results it was concluded that exposure to contaminants during construction and operations of the ferry terminal and stormwater drainage system is not likely to affect protected or managed fishery resources (no effect).

6.3. DISSOLVED OXYGEN

Dredging has the potential to disrupt benthic sediment deposits resulting in re-suspension of fine-grained sediments into the water column. If bottom sediments contained a high percentage of organic material, which through decomposition, resulted in anoxic conditions caused by re-suspension of these sediments would potentially result in a localized reduction in dissolved oxygen concentrations. Reductions in dissolved oxygen concentrations, typically below a level of 6 mg/l, would potentially result in adverse impacts to protected and managed fishery resources exposed to depressed dissolved oxygen levels. Concern has been expressed

regarding dissolved oxygen depression associated with channel and harbor dredge material disposal, which is characterized by a high percentage of silt, clay, mud, and decomposing organic material.

The area within central Bay where dredging for the proposed ferry terminal would occur is characterized by relatively low deposition rates and predominantly a sandy substrate. Sediment samples will be collected and analyzed for chemical contaminants prior to dredging. As a result of these conditions depressed dissolved oxygen concentrations that would be stressful or adversely affect sensitive aquatic species are not expected to occur during dredging. As a precaution, dissolved oxygen measurements will be made during dredging activity using a portable hand held meter. Dredging will be managed to maintain dissolved oxygen concentrations above 6 mg/L.

Based on these results it was concluded that exposure to depressed dissolved oxygen concentrations during dredging for the proposed ferry terminal is not likely to affect protected or managed fish species (no effect).

6.4. SPREAD OF INVASIVE SPECIES

The Bay-Delta Estuary has been colonized by a large number of introduced exotic species. Some species introductions, such as striped bass and American shad, have been made through conscious action while a majority of other species introductions have resulted from the inadvertent transport and release of species into the estuary. Many of the inadvertent species introductions have occurred as a result of ballast water discharges, associated with importation of oysters, as part of fouling communities on ship hulls, and through a variety of other mechanisms. It has been hypothesized that dredging and construction activity would potentially affect the spread of invasive species of fish or macroinvertebrates within the Bay-Delta Estuary through two potential mechanisms, which include (1) the transport and introduction of invasive species into the estuary from other water bodies and (2) disturbance or other changes to subtidal habitat that would favor colonization by invasive species when compared to native species of fish and/or macroinvertebrates or result in an increased vulnerability to predation mortality.

Equipment utilized in dredging and construction of the proposed ferry terminal is consistently moored and operated exclusively within the estuary, and therefore there is no potential for construction activity to introduce new invasive species to the area.

Construction and operation of the proposed ferry terminal and stormwater discharges would not be expected to have any effects on the abundance or distribution of introduced predatory fish species such as striped bass or to result in a direct or indirect increase in the vulnerability of protected fish, including juvenile salmonids, to predation mortality. Juvenile salmonids are characterized as occupying pelagic habitats (upper portions of the water column) and do not forage extensively on benthic macroinvertebrates that colonize subtidal habitats. Based on

these factors it was concluded that the proposed project would not result in an increased risk of adverse effects associated with non-native species interactions with protected fish species. No take of protected or managed fish is expected to occur as a result of proposed project effects on non-native species inhabiting the estuary.

Based on these analyses it was concluded the effects of the proposed project on non-native species is not likely to affect protected and managed fishery resources inhabiting the Bay-Delta (no effect).

6.5. EFFECTS OF SOUND PRESSURE (NOISE)

Construction of the proposed ferry terminal includes the installation of pilings and sheetpile associated with the breakwaters and ferry landing. In recent years concerns have been raised regarding underwater sounds of anthropogenic origin and their potential impacts on aquatic organisms (Popper 2003). Though the majority of research has been focused on marine mammals, there is also potential for underwater sounds to affect protected fish, since many species use sound to find prey, avoid predators, and for social interactions (Popper 2003). Also, the sensory receptors for sound detection are similar to those of marine and terrestrial mammals, and therefore it is possible that sounds affecting marine mammals may also affect fish. It has also been shown that all fishes are able the detect sound within the frequency range of the most widely occurring anthropogenic sounds (Popper 2003).

Anthropogenic sound may have no effect on fish, or may result in various behavioral or physiological responses depending on the lifestage and species of the animal and the intensity and duration of the sound. Behavioral responses may involve the fish swimming away, thereby decreasing the potential physiological effect. Behavioral alterations however, could result in fish leaving a feeding ground or an area associated with reproductive activity. Such behavioral responses that result in longer term behavioral change may subsequently affect survival and reproduction. Direct physiological effects are also possible for various fish species and lifestages resulting in temporary to permanent hearing loss, damage to internal organs and even mortality for sound sources at certain intensities.

Results of studies available in the scientific literature show the awareness thresholds of many species of fish, including Chinook salmon, steelhead, American shad, delta smelt, inland silversides, white sturgeon, catfish, golden shiner and species of macroinvertebrates at various lifestages as well as Pacific herring eggs are not adversely impacted by sound pressure levels of up to 160 dB at frequencies of 300-400 Hz (San Luis and Delta Mendota Water Authority and Hanson 1996) as well as sound pressure levels of 166 dB at 100 Hz (Loeffelman *et al. 1*991). These sound pressure thresholds are levels at which the tested fish species have been found to significantly display behavioral avoidance. These tests resulting in behavioral avoidance have not resulted in sublethal effects or mortality. Some levels of stress or startle reaction have been observed at the described levels when sensitive fish species have been contained in a tank

and exposed to the described levels. It is expected that normal behavior is resumed however when fish are released and are able to naturally avoid the sound source.

NMFS has developed a series of sound pressure thresholds for use in assessing the potential for adverse effects on fish resulting from pile driving. Pile driving and installation of sheetpile that would be used in the proposed ferry terminal breakwaters are typically installed using either a percussion hammer (impact hammer) or a vibratory hammer. The underwater sound pressure generated during pile driving varies in response to a number of factors including the type of equipment and force used to drive pilings into the substrate, the type and size of the piles, the substrate, water depths, and other factors.

The proposed project includes four 42-inch diameter steel fender and guide piles installed on the west side of the float, and two 42-inch diameter steel guide piles installed on the east side of the float. The steel piles will be installed with the use of a vibratory hammer with an energy output of 6,000 ft-lb and a variable frequency between 0 to 1,400 vibrations per minute operated from a barge -mounted crane. The piles will be installed to a depth of embedment of 50-90 feet below the bay bottom, estimated, to be confirmed by geotechnical investigation currently in progress. The pier will be supported by 16 24-inch concrete pier foundation piles that will be installed with the use of a diesel powered impact hammer with approximately 100,000 ft-lb energy output operated from a barge-mounted crane to a depth of embedment of 50-90 feet below the bay bottom, estimated, to be confirmed by geotechnical investigation currently in progress. Pile driving will be limited to a work window extending from June through November. The location, number, and type of piles are shown in Figure 4.4.

The breakwaters will be installed with a diesel powered impact hammer with approximately 100,000 ft-lb energy output operated from barge-mounted cranes. Concrete batter piles (24-inch octagonal at 15-foot centers) will be installed along the basin-interior side of the breakwaters. Between 50 and 60 concrete batter piles will support the north breakwater, and 20 to 30 batter piles will support the south breakwater.

Underwater sound pressure levels will be monitored during pile driving. A sound pressure threshold of 160 dB at 500 meters from the source was established in the EIR for triggering avoidance measures. If the threshold sound level is exceeded or avoidance response by fish is observed by an on-site marine biologist bubble curtains will be used to reduce sound/vibration to acceptable levels. In addition, the final ferry terminal design will use as few piles as possible, a vibratory hammer will be used for all steel piles, cushion blocks will be used between the hammer and pile, and pile driving will be restricted to the period June 1 to November 30 to avoid potential impacts to salmonids and Pacific herring.

NMFS has established a series of threshold criteria for use in assessing potential adverse effects of pile driving on fish. The criteria include 206 dB peak SPL and 187 dB SEL for fish greater than 2 grams and 183 accumulated SEL for fish smaller than 2 grams. The sub-lethal (e.g., behavioral avoidance) threshold is 150 dB RMS. As part of installation of the pilings supporting the floating

docking platform 6 42-inch diameter steelhead piles would be installed using a vibrating hammer. The sound pressure levels generated by the vibrating hammer are lower than those from an impact hammer. Injury to fish has not been observed from a vibrating hammer and therefore it was concluded that installation of the steel piles using the vibration hammer would not impact protected fish or other managed aquatic resources.

The breakwaters and access pier would be supported by a total of 16 24-inch concrete piles for the access pier and up to 90 24-inch concrete piles for the two breakwaters. The concrete piles would be installed using an impact hammer. For purposes of this assessment it was assumed that 200 strikes of the impact hammer would be required to install each pile (Illingworth & Rodkin 2013) and that five piles would be installed per day for a daily total of 1,000 strikes. The estimated peak sound pressure for a 24-inch concrete pile installed using an impact hammer was reported for the Washington State Department of Transportation (Reinhall and Dahl 2011) to range from 190 to 205 dBpeak. Reinhall and Dahl (2011) reported that no fish kills have been observed associated with installation of concrete piles. Data on 24-inch concrete piles installed at Pier 40 in San Francisco (Caltrans 2012) had had peak sound pressures in the range from 180 to 186 dB and RMS in the range of 169 to 174 at 10 meters. Sound pressure measurements for 24-inch concrete piles driven at Berth 22 in the Port of Oakland averaged 187 dB peak, 176 dB RMS, and 166 dB SEL at 10 meters. Similar sound measurement data for 24-inch concrete pile driven at Berth 32 at the Port of Oakland indicated that the average sound levels were 185 dB peak, 173 dB RMS, and 161-163 dB SEL. For purposes of this assessment an assumed peak sound pressure level of 185 dB at 10 meters, 174 dB RMS, and 165 dB SEL was required to stay within the general range of measurement values observed in these studies. Using these values in the NMFS spreadsheet (Appendix A) and assuming 1,000 strikes per day the cumulative SEL at 10 meters was 195, the peak 206 dB threshold was not exceeded (0 distance), the cumulative SEL for fish greater than 2 grams was 34 meters, the cumulative SEL for fish less than 2 grams was 63 meters, and the behavior RMS threshold of 150 dB was met at 398 meters. As a sensitivity analysis the model was also run assuming 2,000 strikes per day with an estimated cumulative SEL at 10 meters of 198 dB, the lethal threshold of 206 dB was not met (o distance), the cumulative SEL for fish greater than 2 grams was met at 54 meters, the cumulative threshold for fish less than 2 grams was met at 100 meters, and the behavioral threshold of 150 dB RMS was met at 398 meters. Based on these results it was concluded that the proposed pile driving would not result in fish mortality but that noise disturbance resulting from pile driving would be expected to result in a behavioral avoidance of the construction area during pile driving using the impact hammer to install 24-inch concrete piles.

Based on these considerations it was concluded that underwater sound generated during pile driving and sheetpile installation at the proposed ferry terminal may affect (behavioral avoidance), but is not likely to adversely affect, protected and managed fish species.

6.6. SHADING

Habitat conditions for a number of fish, macroinvertebrates, and aquatic plants are affected by extensive shading. In some instances, predatory fish are known to use shaded areas as hiding habitat thereby increasing the risk of small fish such as juvenile salmonids or longfin smelt to predation. The proposed ferry terminal includes breakwaters, an elevated access pier, gang plank, and floating landing docks for ferry mooring. The two proposed breakwaters will be oriented vertically in the water column and will extend above the water surface. At a low sun angle (e.g., late afternoon) the breakwaters would result in an increase in the local area in diffused shade. The access pier with a deck elevation of 11.5 feet would be supported by a series of pilings. As a result of the height of the access pier deck sunlight will be able to reach the water surface and the deck would result in localized diffused shading. The gangway and mooring floats would extend down to the water surface and would result in dense shading. Where possible, based on design and safety open grate material may be used on the access pier and gangway to reduce shading effects. Based on these design considerations it was estimated that the ferry terminal elements could result in an area of approximately 11,900 ft^2 (Table 4-2) of shaded habitat.

Increasing the area of shaded aquatic habitat associated with the proposed ferry terminal may affect (increased risk of predation and reduced habitat suitability) protected fish and other managed aquatic resources. The incremental increase in shaded habitat of 11,900 ft^2 in central Bay, however, would not be expected to result in jeopardy to the continued existence of any protected fish species.

6.7. MIGRATION AND HABITAT USE

The Bay-Delta Estuary provides habitat supporting a diverse assemblage of fish and macroinvertebrate species. Subtidal habitats within Central Bay support larval dispersal and rearing, juvenile rearing, migratory pathways, and subadult and adult holding and foraging habitat as well as a migration corridor for juvenile and adult salmonids and sturgeon. The fish and macroinvertebrate assemblage inhabiting Central Bay is characteristic of marine coastal waters, and species having a higher tolerance to salinity.

Fish inhabiting Central Bay could periodically be exposed to elevated suspended sediment concentrations associated with dredging within the ferry terminal as well as increased localized and temporary turbidity resulting from entrained air into the ferry prop wash (Section 6.1). Central Bay is characterized by high suspended sediment concentrations seasonally as a result of increased freshwater inflow from the Sacramento and San Joaquin river systems and/or resuspension of fine sediments from shallow-water areas within the estuary as a result wind-driven and tidal currents and turbulence.

Increased suspended sediment concentrations could also result in temporary, localized, reductions in foraging success by juvenile salmonids and juvenile and adult green sturgeon and other fish. Exposure to elevated suspended sediment concentrations associated with ferry terminal dredging activity and operations is anticipated to be relatively short duration (e.g., minutes or hours) and therefore, reductions in prey capture ability as result of ferry activity would not be expected to result in detectable changes in growth rates, condition, or survival of fish inhabiting the estuary.

Information on the geographic distribution and habitat use by salmonids (there is very little data on green sturgeon) has shown that juvenile and adult lifestages occupy subtidal pelagic habitats within Central Bay during migration to and from the ocean. Green sturgeon also rear, forage, and use Central Bay as a migratory pathway. Many of these fish inhabit open water areas within Central Bay and are not associated with shallow subtidal or intertidal areas adjacent to Treasure Island. Juvenile Chinook salmon, sturgeon, and other fish species of interest including longfin smelt may inhabit shallow water areas for both foraging and movement. Installation of the two breakwaters and ferry terminal create physical structures that may impede movement along the Treasure Island shoreline as well as create habitat that attracts predatory fish and increases the risk of predation mortality. The potential magnitude of these effects on protected and managed aquatic resources cannot be quantified.

Given the length of the proposed breakwaters (approximately 765 feet and 340 feet, north and south breakwaters, respectively) and other ferry terminal facilities it was concluded that the proposed project may affect protected and managed aquatic species (increased risk of predation and reduced habitat suitability). The incremental increase in shaded habitat of 11,900 ft^2 in central Bay, however, would not be expected to result in jeopardy to the continued existence of any protected fish species.

6.8. EFFECTS ON BENTHIC DISTURBANCE

Ecological communities exist in a continual state of flux. Organisms die and others are born to take their places. Pioneering species adapted to the disturbed habitat are successively replaced by others until the community approaches its former structure and composition. This sequence of changes, called succession, varies in response to different starting positions. Primary succession is usually reserved for the development of a community in an area that consists of newly formed habitat, such as lava flows or rock exposed by a receding glacier, while secondary succession is usually applied to areas that have had a major disturbance, such as a tornado, fire, or anthropogenic perturbation.

Habitat disturbance in estuaries, such as the San Francisco Bay-Delta, is a continuous process. To survive in an estuary, an organism must adapt to a wider range of fluctuations in environmental factors than in the open ocean or in fresh water. Optimum development or successful colonization in an estuary may depend on the interaction of several factors, including

salinity, temperature and turbidity, and substrate, in the case of benthic organisms. Repeated deposition and resuspension of the same sediments are predominant characteristics in the San Francisco Bay-Delta estuary. Superimposed on typical seasonal cycles of deposition and resuspension are intense periods of erosion or deposition that can rapidly change the sediment surface (Nichols and Pamatmat 1988). In addition to these natural perturbations, man-made factors such as fishing (e.g., Messieh *et. al.* 1991; McConnaughey *et. al.* 2000; De Groot 1984; Caddy 1973; NAS 2002; Pitcher *et. al.* 2000; Rumohr and Krost 1991; Riemann and Hoffmann 1991; Eleftheriou and Robertson 1992) dredging (e.g., de Grave and Whitaker 1999; Harvey *et. al.* 1998; Jones 1986; Jones 1981; Rosenberg 1977; Rhoads *et. al.* 1978; ACOE 1976, 1977, 1982, 1984; FWS 1970; Jones and Candy 1981; Flemmer *et. al.* 1997), sand and gravel extraction (e.g., Desprez 2000; Sardá *et. al.* 2000; Seiderer and Newell 1999; Van Dalfsen *et. al.* 2000), waste water discharge, urban runoff, and other disturbances further affect the distribution and composition of bottom fauna.

Nichols and Pamatmat (1988) describe both seasonal and aperiodic patterns in the benthic community in the Bay-Delta estuary. Seasonal patterns of abundance generally follow the annual temperature cycle, with some species having two generations per year, leading to two peak periods of abundance. However, the marked fluctuations in benthic abundance are also strongly influenced by aperiodic processes such as environmental perturbations caused by extreme deviations in the physicochemical environment, including periods of high freshwater runoff, extended drought periods, effects of pollution and freshwater diversions, as well as other factors such as species interactions, and most importantly, species introductions.

Ranasinghe *et al.* (2007) evaluated five indicators of benthic community condition within San Francisco Bay. USGS has also been conducting seafloor mapping and benthic habitat studies in Central Bay using backscatter images and other survey methods. An atlas of benthic macroinvertebrates and spatial database for San Francisco Bay has been developed by USGS (Rowan *et al.* 2011).

A review by Newell *et al.* (1998) indicates that benthic communities living in fine mobile deposits, such as occur in most estuaries, are characterized by large populations of a diversity of species that are well adapted to rapid recolonization of deposits that are subject to frequent disturbance. Recolonization of dredged areas is usually by opportunistic species characterized by the early stages of secondary succession, and is followed by an increased diversity of species that are longer-lived and slower growing as the succession progresses. Newell *et al.* (1998) state that rates of recovery reported in the literature suggest that a recovery time of 6 to 8 months is characteristic of many estuarine muds where frequent disturbance precludes the establishment of long-lived species. They further state that communities in sand and gravel could take 2 to 3 years to establish, depending on levels of disturbance by waves and currents. However, simple particle size distribution is most likely not the sole controlling factor, and an array of environmental factors including particle mobility and chemical and biological interactions are more likely. The long-term effects of dredging are probably more profound in

estuaries and bays that are small and shallow compared to larger, deeper estuaries. Kaplan *et al.* (1974) studied populations of epibenthic and infauna in a shallow lagoon in Long Island, NY from 10 months prior to 11 months after a navigation channel was dredged, and found that the benthic fauna was greatly affected by the dredging, and overall benthic productivity was reduced by more than half after the dredging took place. However, the authors believed that the profound effects of the dredging were due to the relatively small size and depth of the area, where the dredging caused changes in current velocity and sedimentation patterns.

A study of environmental effects of dredging off the coast of Sardinia, Italy by Pagliai *et al.* (1985) showed that the benthic communities recolonized the dredged area rapidly. Although six months after dredging, the benthic communities showed similar structural parameters (number of species, number of individuals, diversity, evenness, dominance, etc.) to the non-dredged areas, there were qualitative differences (intergroup similarity) between the two areas that suggest that the recovery process was not fully completed.

Bell and Devlin (1983) studied short-term recolonization rates (time scales of hours and days) in Tampa Bay, Florida after experimentally removing organisms from small sediment patches (100 cm^2). They found that within 7.5 hours after defaunation, densities of dominant macrofauna returned to control levels. Their investigation found that benthic crustaceans and adult polychaetes were present in the water column and rapidly repopulated the defaunated areas. These studies indicate that adults can rapidly recolonize small patches of disturbed habitat, but the results are greatly dependent upon the size of the disturbed area, the contiguity of undisturbed areas to the defaunated site, and the method of defaunation.

A larger-scale investigation was conducted by Kenny and Rees (1994) in the seabed of the English east coast in 1992. In this study, approximately 52,000 tons of mixed aggregate was dredged from an area measured at 500 x 270 m to a depth of approximately 0.3 m, using a commercial suction-trailer dredge. Grab samples taken at the dredged site were compared to a nearby reference site to determine benthic recovery. The results showed that during the 8-month sampling period, the number of species at the dredged site fell from 38 to 13 immediately following dredging, and increased to 26 species during the 7-month post-dredging period, suggesting some recolonization had occurred. Both abundance and biomass of benthic organisms also fell immediately following dredging. The average abundance of benthic organisms rose again after the initial decline, but total biomass did not greatly increase during the 7 months post-dredging. An analysis of mean weights per individual at the dredged site indicated that while the numbers of organisms increased post-dredging, their mean individual biomass fell, indicating that the individuals present at the site were new recruits. Over a two-year period following the initial investigation Kenny and Rees (1996) repeated the sampling of the dredged and reference sites. A significant increase in the number of species occurred at the dredged site over the 12 months following dredging, and was not significantly different from the reference site or the pre-treatment dredged site. Abundance and biomass values were in general agreement with the trend for number of taxa. The general results of the study indicate

that the greatest amount of recolonization occurred within the months immediately following the dredging, and that smaller, rapid-growth species (r-selected) are the first recolonizers, followed by the slower-growing (K-selected) species.

Another investigation conducted by Hily (1983) followed the recolonization of benthos in a sandy region in the Bay of Brest (France) for 3 years following a dredging event. Species abundance, diversity, and biomass values followed the main phases of ecological succession: (1) reorganization of the chemical and microbial processes, (2) establishment of a pioneer community characterized by opportunistic species, (3) establishment of a young and robust community with high diversity and production, (4) maturation of the community with high interspecific competition, lower productivity and longer growth rates, and (5) negative evolution as the community begins to oscillate, with dominant species, possibly caused by nutrient enrichment from the dredging activity.

There are several factors that would affect the impact of dredging and other in-water project facilities such as the breakwater, floats, and the pier on benthic communities:

- Distribution of species within the region of the estuary;
- Life cycle, dispersal and colonization, and growth rates of the species;
- Characteristics of the benthic macroinvertebrate community (community diversity and richness) within the area where dredging occurs, including species composition, abundance, and life histories;
- Both spatial and temporal intensity of dredging activity within an area;
- Percentage of available benthic habitat disturbed (degree of sediment disturbance);
- Recolonization rate, dispersal, transport, and growth of the benthic community normally inhabiting the area; and
- Physical characteristics and conditions occurring within the subtidal area where dredging occurs.

The proposed construction of the ferry terminal would require dredging approximately 6,000 CY of sediment disturbing benthic habitat in an area of approximately 0.55 acres. Dredging would remove existing benthic organisms (e.g., clams, worms, etc.) from the area. After dredging is completed the benthic subtidal habitat would be recolonized by benthic and epibenthic species from other parts of Central Bay or coastal marine waters. Recolonization of the benthic habitat is expected to occur quickly with those species that have widely dispersed lifestages and species that have evolved and adapted to colonize habitat immediately after disturbance. Other species are expected to take a longer period of time (months to years) before recolonization of the subtidal area is complete. Many of the protected fish and managed fish under EFH forage on benthic species and dredging would result in an incremental

reduction in foraging opportunities within the ferry terminal complex until benthic recolonization has occurred. The removal of benthic organisms from an area of Central Bay of 0.55 acres would not preclude fish from effectively foraging in adjacent areas until recolonization had occurred.

Based on the small area of benthic habitat that would be disturbed by dredging during construction of the ferry terminal and maintenance dredging at a intervals of more than 2 years, the proposed project would result in a reduction in foraging opportunities that may affect (short-term, incremental reduction in foraging habitat), but is not likely to adversely affect, protected and managed fishery resources.

6.9. HABITATS OF PARTICULAR CONCERN

6.9.1. Eel Grass Beds

Direct impacts of the proposed project on eel grass are not expected since the ferry terminal would not be located in an area where eel grass occurs. The distribution of eel grass beds in Central Bay (Hanson *et al.* 2004) shows relatively small areas colonized in Richardson Bay, adjacent to the Alameda shoreline south of the Bay Bridge, near the Emeryville Marina, and in several locations along the Richmond shoreline. No eel grass beds were identified in the vicinity of the proposed Treasure Island ferry terminal although eel grass beds are known to be present at other locations along the northern and eastern Treasure Island shoreline, and on the northern shoreline of Yerba Buena Island in Clipper Cove (Merkel & Associates 2008, 2010).

The proposed project includes limiting ferry routes to reduce potential disturbance to sensitive intertidal and shallow subtidal habitats and the use of techniques such as silt curtains in the event that dredging results in a risk of indirect effects on eel grass beds. Prior to initiating construction of the ferry terminal an additional eel grass survey would be conducted to verify that no eel grass has colonized the ferry terminal area. The project design and construction have been developed to avoid impacts to eel grass.

The renovated storm drainage system included as part of the proposed project has the potential to effect eel grass through local temporary changes in salinity associated with freshwater discharges and the discharge of contaminants such as herbicides from the expanded residential and commercial development on the island. Changes in local salinity associated with stormwater discharges are expected to be very localized and temporary. The freshwater discharge would rapidly mix with saltwater in Central Bay and would not be expected to adversely affect eel grass. The storm drainage system proposed as part of the project includes pre-discharge treatment that would reduce the risk of contaminant effects on eel grass in the vicinity of the discharges.

As a result of the minimization and avoidance measures included in the proposed project no significant impacts to eel grass beds are expected to occur.

6.9.2. Native California Oyster Beds

Benthic studies in the area of Treasure Island by Applied Marine Sciences (AMS 2009) identified native oysters inhabiting the lower intertidal zone on Treasure Island with the greatest densities along the west and north shorelines. The proposed construction of the ferry terminal and stormwater discharges would not be expected to adversely impact intertidal areas where native oysters occur. Surveys would be conducted prior to construction in each area to verify that native oysters are not present in the area where construction would occur. As discussed above for eel grass BMPs included as part of the proposed project, including pre-discharge treatment of stormwater, serve to minimize and avoid potential effects to native oysters. No significant impacts are expected to occur to native oysters as a result of construction or operation of the proposed project.

7.0 CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR §402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." Given the presence of ESA listed fish and designated critical habitat and EFH in the Central Bay few future non-Federal actions that may affect the action area are expected to occur. The proposed construction of additional marina facilities in Clipper Cove on Yerba Buena Island has the potential to result in cumulative impacts with the proposed project but would require Federal permits. Most actions that are anticipated to occur in Central Bay would require Federal permits and would undergo individual or programmatic section 7 consultation.

Since no known specific and reasonably certain State of private actions or activities are expected to occur in the action area that are not subject to Section 7 consultation, no cumulative effects are expected to occur that would need to be addressed as part of this biological assessment or section 7 consultation.

8.0 CONCLUSIONS AND DETERMINATIONS

This section discusses the conclusions of this BA that were formulated using the discussion of potential species present, habitat presence and suitability, and project effects discussed in previous sections.

The potential effects of the proposed ferry terminal and stormwater discharge system within Central San Francisco Bay, with terms and conditions outlined in this biological assessment, have been assessed. The assessment included consideration of the following issues:

- Increased suspended sediment concentrations and turbidity;
- Contaminants and toxicity;
- Changes to dissolved oxygen levels;
- Spread of invasive species;
- Increased shading;
- Effects of sound pressure (noise);
- Migration and habitat use;
- Benthic disturbance; and
- Effects on habitats of particular concern.

Based on results of the assessment it was concluded that the proposed project within Central San Francisco Bay may affect, but is not likely to adversely affect, protected and managed fish species directly through:

- Avoidance behavior of sublethal increases in suspended sediments and turbidity associated with dredging activity;
- Behavioral avoidance of the construction area during installation of concrete piles using the impact hammer;
- Increased shading;
- Migration and habitat use; and
- Benthic disturbance.

The Project Description and implementation of measures designed to avoid and minimize incidental take of winter-run or spring-run Chinook salmon, Central Valley and Central California Coast steelhead or green sturgeon will not result in jeopardy to the continued existence of these species or significant adverse modification to their critical habitat.

Based on results of these analyses it was concluded that the proposed project construction and operations in Central Bay may affect protected and managed fish species. This BA concludes that the proposed project is not likely to adversely affect the continued existence of winter-run or spring-run Chinook salmon, Central Valley or Central California Coast steelhead, or green sturgeon (non-jeopardy) or result in adverse modification to their critical habitat.

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APPENDIX A

Project Title	Treasure Island ferry terminal
Pile information (size, type, number, pile strikes, etc.)	See project description

Fill in green cells: estimated sound levels and distances at which they were measured, estimated number of pile strikes per day, and transmission loss constant.

	Acoustic Metric			
	Peak	SEL	RMS	Effective Quiet
Measured single strike level (dB)	**185**	**165**	**174**	**150**
Distance (m)	**10**	**10**	**10**	

Estimated number of strikes	**1000**

Cumulative SEL at measured distance
195.00

	Distance (m) to threshold			
	Onset of Physical Injury			Behavior
	Peak	Cumulative SEL dB**		RMS
	dB	Fish ≥ 2 g	Fish < 2 g	dB
Transmission loss constant (15 if unknown)	206	187	183	150
15	**0**	**34**	**63**	**398**

** This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet)

Notes (source for estimates, etc.)

Project Title	Treasure Island ferry terminal
Pile information (size, type, number, pile strikes, etc.)	See project description

Fill in green cells: estimated sound levels and distances at which they were measured, estimated number of pile strikes per day, and transmission loss constant.

	Acoustic Metric			
	Peak	SEL	RMS	Effective Quiet
Measured single strike level (dB)	**185**	**165**	**174**	**150**
Distance (m)	**10**	**10**	**10**	

Estimated number of strikes	**2000**

Cumulative SEL at measured distance
198.01

	Distance (m) to threshold			
	Onset of Physical Injury			Behavior
	Peak	Cumulative SEL dB**		RMS
	dB	Fish ≥ 2 g	Fish < 2 g	dB
Transmission loss constant (15 if unknown)	206	187	183	150
15	**0**	**54**	**100**	**398**

** This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet)

Notes (source for estimates, etc.)