

SAN FRANCISCO RECREATION AND PARKS DEPARTMENT



**PROJECT DESIGN CRITERIA**  
for  
**WEST HARBOR MARINA RENOVATION**

TECHNICAL MEMORANDUM

November 10, 2009

*Prepared By*



# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

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# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## 1. INTRODUCTION

### 1.1 BACKGROUND

The City and County of San Francisco, Recreation and Parks Department (RPD) has retained Winzler & Kelly (W&K) to perform site investigations, studies and preliminary design of the public marina facility known as the West Marina Harbor in San Francisco. RPD oversees the operation of two public boat marinas (in the City's Marina District) that are to be renovated and upgraded as part of the overall improvements.

This document presents the project design criteria to be used for the preliminary engineering design of repairs, rehabilitation and/or construction of new structures for the West Marina Harbor. W&K's preliminary design will be included in the documents of a design-build Criteria Package for final design and construction of the proposed improvements.

### 1.2 SAN FRANCISCO MARINA CONFIGURATION AND EXISTING CONDITIONS

The San Francisco Marina is located on the Northern Waterfront of the City of San Francisco in an area known as the Marina District. The Marina is approximately one and one-half miles east of the Golden Gate Bridge and just west of Fort Mason. The marina is located on property under the jurisdiction of the San Francisco Recreation and Park Commission. The marina adjoins lands of the Golden Gate National Recreation Area (GGNRA) both to the East (Lower Fort Mason) and to the West (Crissy Field).

The San Francisco Marina is composed of two harbors, known as East Harbor (also known Gashouse Cove) and West Harbor. The Marina Green, a part of the marina and a major city park, is situated between the East and West Harbors. The East Harbor consists of 342 boat slips, the City Yachts sales and fuel concession, and parkland, which includes a restroom and two parking lots. The West Harbor consists of the West Harbor marina, the Saint Francis and Golden Gate Yacht Clubs, the Harbor Office Building, and parkland that includes restrooms, a concession stand, Degaussing Station and four parking lots. There are currently 322 slips in the West Harbor. The West Harbor's original design capacity of 344 has been reduced over the years by storm damage and general deterioration. Not included in the total number of slips in the West Harbor are berths leased to St. Francis Yacht Club.

The West Harbor is generally bounded by Marina Boulevard and the western end of the Marina Green to the south, Yacht Road and the outer jetty to the north, the harbor entrance to San Francisco Bay to the east, and Yacht Road to the west. The West Harbor covers about 1,100,000 square feet of water area in two basins: an inner basin and an outer basin (about 39 acres in total for both

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harbors). The West Harbor marina facilities include the Harbor Office building (which also houses a public restroom and tenant showers), a public restroom, a refreshment concession stand, four parking lots, and slips to accommodate 322 boats. The Recreation and Park Department also uses a San Francisco Public Utilities Commission (SFPUC) pump station as a maintenance building in the West Harbor to support marina operations. Adjacent to the West Harbor but outside of the project area are the St. Francis and Golden Gate Yacht Clubs, a miniature lighthouse (no longer in use), and the wave organ at the tip of the north jetty.

### Existing Conditions

The San Francisco Marina facilities have existed in their present configuration since 1963. The floating docks and gangways are made of timber and have degraded over time. The on-dock utilities have degraded as well as become obsolete.

### Project Objectives Summary

The San Francisco Marina Renovation Project consists of renovations to facilities in both the East and West Harbors of the San Francisco Marina. The project includes waterside improvements over the entire 39-acre waterside portion of the marina and on 12 of the total 19 landside acres, as well as renovation of the 700-square-foot former U.S. Navy Degaussing Station for use as a new Harbor Office. Approvals and funding is in place to implement Phase I of the project, renovation of the West Harbor.

Proposed waterside marina renovations in the West Harbor include:

- two new breakwater segments
- complete or partial removal of two breakwater structures (moles) near the foot of Scott Street
- reconstruction of portions of the degraded riprap slopes around the interior shorelines
- replacement and reconfiguration of the floating docks and slips
- renovation of existing pumpout facility
- construction of a dedicated guest dock and hand boat launch
- maintenance dredging

Other waterside project components include replacement of gangways and security gates; refurbishment of the existing sewage pumpouts; and upgrades of electrical and water services to the new floating docks and improved lighting on the floating docks.

Improvements will also include upgrades in electrical service, water system and fire protection stations, and replacement of gates, ramps and gangways. The landside project improvements will include full Americans with Disabilities Act (ADA) upgrades to Harbor Office, renovation of the public restrooms in the

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Harbor Office and conversion of the existing office space (400 square feet) into showers, and also potential renovation of the former U.S. Navy Degaussing Station (now vacant) for use as the new Harbor Office. Landside improvements for accessibility will be included. Public access improvements would be made to the public restroom. ADA-compliant access ramps would be added in the West Harbor and access modifications to the parking lot.

Construction of the proposed project will occur under a design-build contract and is expected to begin in 2010 and is expected to take up to about 20 months.

### 1.3 ORGANIZATION

This document is organized into the following ten sections:

**Section 1, “INTRODUCTION,”** provides a general overview of RPD’s West Marina Harbor Wharf project and an overview existing condition and proposed improvement in this Design Criteria document.

**Section 2, “CODES AND STANDARDS,”** lists the codes and standards applicable to the structural design of a new substructure, including possible repairs and/or rehabilitation of existing substructure.

**Section 3, “GENERAL CRITERIA,”** lists applicable general criteria such as location, orientation, and applicable units of design.

**Section 4, “COASTAL AND MARINA STRUCTURES CRITERIA,”** lists applicable environmental criteria and data applicable to coastal structure design, such as current and wind speeds, tide variation, and operating and extreme wave heights and associated periods.

**Section 5, “GEOTECHNICAL CRITERIA,”** lists applicable geotechnical criteria and data applicable to the design of substructures, such as site soil profiles, associated vertical and lateral pile-soil resistance parameters, and scour (if applicable), liquefaction and settlement potential. These criteria were obtained from past geotechnical information provided by the City at this facility and at nearby sites and by performing site geotechnical investigations as a part of this project.

**Section 6, “FUNCTIONAL CRITERIA,”** presents applicable functional criteria and data applicable to the renovation design, such as type of construction, materials and project related loads.

**Section 7, “DESIGN LOADS,”** documents the applicable design loads that may be applicable to the design of the project structures.

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**Section 8, “MATERIALS,”** documents acceptable materials to be used to fabricate new structures or for rehabilitation. Materials of equivalent engineering performance to those used in design may be proposed by the fabricator and used subject to Engineer’s approval. Structural steel, aluminum, timber, polymers, concrete and grout materials are included.

**Section 9, “APPURTENANCES,”** lists the engineering design criteria for various appurtenances associated with this project including vessel moorings, electrical service, fire protection, access, safety, security and navigation and installation aids.

**Section 10, “REFERENCES,”** lists documents referenced by this Design Criteria.

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## 2. CODES AND STANDARDS

The design requirements of the following design codes and standards shall be incorporated into the design of the West Marina Harbor:

- 2.1 San Francisco Building Code, City and County of San Francisco
- 2.2 California Building Standards Commission, "2007 California Building Code (CBC)," California Code of Regulations, Title 24, Parts 1 and 2, 2007.
- 2.3 International Code Council, "2006 International Building Code (IBC)," 2006.
- 2.4 American Society of Civil Engineers, "Minimum Design Loads for Buildings and Other Structures," ASCE/SEI 5-07, 2006.
- 2.5 American Institute of Steel Construction (AISC), "Manual of Steel Construction, Allowable Stress Design," Ninth Edition, 1989.
- 2.6 American Welding Society (AWS), D1.1, 2006.
- 2.7 American Concrete Institute (ACI), "Building Code Requirements for Structural Concrete (318-05)," 2005.
- 2.8 California Department of Boating and Waterways (DBAW), "Layout and Design Guidelines for Marina Berthing Facilities," 2005.

### **Marina Design Standards and Guidelines**

- 2.9 "Layout and Design Guidelines for Marina Berthing Facilities," by California Department of Boating and Waterways, State of California, July 2005.
- 2.10 "Planning and Design Guidelines for Small Craft Harbors," American Society of Civil Engineers, 1994.
- 2.11 "Marinas and Small Craft Harbors," Tobiasson and Kollmeyer, 2<sup>nd</sup> edition, 2000.
- 2.12 "Ferry Terminals and Small Craft Berthing Facilities," MIL-HDBK-1025/5, 1988.
- 2.13 Tsinker, Gregory, "Floating Ports – Design and Construction Practices," 1986.

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- 2.14 National Fire Protection Association (NFPA) Code 303: Fire Protection Standards for Marinas and Boatyards
- 2.15 Winzler & Kelly, "Engineering Study of Concrete Berthing Systems," 1979.

### **Coastal Design Standards and Guidelines**

- 2.16 "Criteria for Movements of Moored Ships in Harbours, Permanent International Association of Navigation Congress (PIANC)," 1995.
- 2.17 "Floating Breakwaters – A Practical Guide for Design and Construction," PIANC, 1994.
- 2.18 "Coastal Engineering Manual (CEM)," EM 1110-2-1100, Coastal Engineering Research Center, US Army Corps (USACE), 2002.
- 2.19 "Shore Protection Manual," Coastal Engineering Research Center, US Army Corps (USACE), 4<sup>th</sup> Edition, 1984.

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## 3. GENERAL CRITERIA

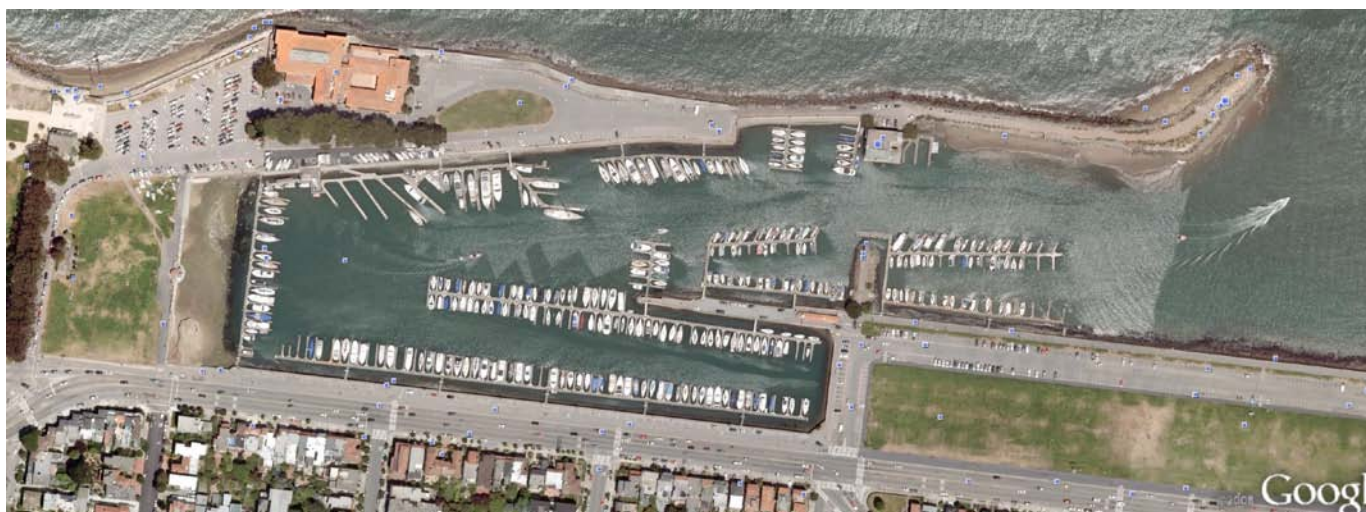
### 3.1 FUNCTION

The West Marina Harbor redesign shall provide a renovated public marina with new berth slips, a new guest dock, new handicap access to the water, and improved public access and amenities along the scenic walkway (SF Bay Regional trail) in the Marina District of San Francisco, California. Marina boaters will have access to during operation, maintenance and upgrade of these facilities.

### 3.2 LOCATION

West Harbor Marina is located on the northern side of San Francisco on San Francisco Bay in California. It is located just east of Crissy Field and west of Fort Mason (Figure 3-1) at approximately:

Latitude: 37° 48' N  
Longitude: 122° 27' W



**Figure 3-1: West Harbor Marina – Project Site**

The West Harbor Marina project area encompasses about 1,100,000 square feet of water. Much of the site lies adjacent to historic seawalls and the north jetty which protects the north side of the site from sea and swells. The existing marina has fairway depths of about -10 to -12 feet mean lower low water (MLLW) with less draft currently in the berths. The outer harbor (east side of the site) is deeper and exposed to swell from the northeast. For this reason new breakwater structures are proposed to protect the harbor entrance.

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### 3.3 ORIENTATION

The West Harbor Marina site is aligned approximately in an east-west orientation with the City of San Francisco (Marina Boulevard) to the south and San Francisco Bay to the north.

### 3.4 OPERATING LIFE

The minimum service life of the West Harbor Marina improvements is assumed to be 30 years (to meet requirements of the project funding).

### 3.5 LIFE SAFETY

The West Harbor Marina facilities will be occupied by the general public on a continuous basis. All facilities will be occupied by City personnel during shorter periods of maintenance or repair. Access to the guest dock will be controlled. Access to the hand-powered boat launch and public dock will be controlled by the City through access features such as fencing and locked gates.

### 3.6 SPILLAGE AND CONTAMINATION

The West Harbor Marina does not have a refueling facility at the site; the closest fuel dock is at the East harbor, about ½ mile east of the site. For this reason, no significant quantities of contaminants are expected at the West Harbor Marina on a permanent basis. The existing sanitary pump-out facility will be re-used at a new location within the marina.

### 3.7 CONSEQUENCE OF FAILURE

There appear to be no unusual consequences of failure of the West Harbor Marina floats and waterfront structures with respect to life safety or the environment. This facility is deemed an ordinary facility with respect to emergency response and need not remain operational after a natural disaster such as a severe earthquake. The Marina Blvd and James Fair seawalls will not be seismically strengthened as part of this project.

### 3.8 STRUCTURE REMOVAL

Removal of the existing floats and waterfront structures includes at least removal, disposal, and some recycling of the following material: existing timber floats with foam flotation; existing electrical and related hardware; existing ramps (mainly timber); existing guide piles (mostly timber, some with creosote coating); removal of rubble fill (moles) and revetment. The demolition (or removal) work will be conducted in phases to keep most of the marina operational throughout the anticipated 20-month construction period.

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## 3.9 UNITS

Engineering and design shall use English units as follows:

Length:	Feet and/or inches
Force:	Kips or pounds
Unit force or loading:	pounds per square foot
Time:	Seconds
Temperature:	Degrees Fahrenheit

Other units may be used if their English unit equivalents are also provided.

## 3.10 CONSTANTS

The following constants shall be used for design:

Density of seawater:	64.0 pcf
Density of steel:	490 pcf
Density of aluminum:	170 pcf
Density of normal wt. concrete:	145 pcf
Density of light wt. concrete:	118 pcf
Density of grout:	150 pcf
Density of timber	40 pcf

Gravitational acceleration: 32.2 ft/sec<sup>2</sup>

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## 4. COASTAL AND MARINA STRUCTURES CRITERIA

Preliminary design documents will reference MLLW.

### 4.1 WEST HARBOR BASIN WATER DEPTH

The present water depth within the West Harbor basin was determined by hydrographic survey to vary between approximately 10 feet maximum with respect to MLLW. Mudline elevation varies from Elevation -3.5' to Elevation -13.6' MLLW. Design depths for the renovation project are shown in Section 4.7 below.

### 4.2 TIDAL DATA

<b>TIDAL DATA – SAN FRANCISCO, NOAA STATION ID: 9414290</b>		
	<b><u>ELEV (FT)</u></b>	<b><u>ELEV (M)</u></b>
Mean Higher High Water (MHHW)	5.84	1.780
Mean High Water (MHW)	5.23	1.595
Mean Low Water (MLW)	1.14	0.346
Mean Lower Low Water (MLLW)	0.00	0.000
North American Vertical Datum – 1988 (NAVD)	-0.06	-0.018

TABLE 1

### 4.3 DESIGN WIND

Design extreme wind shall be based on Reference 7 and is 85 mph, 3-second gust, Exposure D, per the International Building Code. Design wind shall be assumed to act collinear with design waves and current.

### 4.4 DESIGN WAVE

A study was conducted to determine the following:

- Storm wave conditions to evaluate wave protection performance (operating design wave, significant wave height, 1-year return period and extreme design wave, significant wave height, 50-year return period)
- Storm wave conditions to prepare design (max wave height, 50-year return period)

Design waves for evaluating breakwater performance are 1-year and 50-year events. The extreme wave condition for breakwater design is based on a return period of 50 years. The results of the analysis are summarized in Table 2 below.

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<b>WAVE ANALYSIS</b>				
Return Period	Wave Protection Performance		Design	
1-year	Hs = 1.1ft	Tp = 2.7sec	-	-
50-year	Hs = 2.7ft	Tp = 4.0sec	Hmax = 6.0ft	Tp = 3.6sec

**TABLE 2**

- Maximum tidal current speed of 4 feet per second will be used for design of the breakwaters.

## **4.5 100-YEAR PREDICTED SEA LEVEL RISE**

The proposed improvements at the West Harbor Marina will be designed to accommodate the anticipated sea level rise within the life of the DBAW loan. The accommodations for the gangways, guide piles and breakwaters will be made where practical and economically viable.

Sea level rise estimates over the next 50 years range from 4 to 16 inches. The renovation design will accommodate the more conservative 16" of sea level rise in the next 50 years provided cost impacts are not significant.

## **4.6 DESIGN FATIGUE DATA**

In general, cyclic stresses due to wave loading will be considered in the design of the pile guides and floating docks. Fatigue considerations will be accounted for per AISC recommendations for steel components, where applicable.

## **4.7 MARINA LAYOUT AND FLOATING BERTHS**

The berthing system consists of a series of floats held in place by vertical guide piling. Access to the floating docks will be provided by aluminum gangways from the existing seawalls. The revised distribution of berths in the West Harbor Marina has a target of meeting the EIR total of 325 slips. The average length of each slip will be approximately 38'-6". The revised orientation of the floating docks will take the prevailing winds into consideration and is intended to facilitate access to the berths by sailing as well as power craft, as there are increasing numbers of small sailing craft that berth without the aid of auxiliary power.

Double berths will be provided for slips less than 60 feet in length for reasons of economy and minimization of bay "fill" (i.e., a single finger float serves two berths). The widths of the berths are given on Table 5. The width is a function of berth length, and is intermediate between those recommended for sail and for

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power boats. Two widths are given in certain cases because it is suggested that where berths of different lengths are on opposing sides of a main walkway, the finger floats should still align. Consideration will be given to the berth widths for sail boats, as beam dimensions have increased in recent years.

Dimensions for new berths, walkways, floats and dredge depths will generally follow California Department of Boating and Waterways. A variance may be required in some cases for budgetary purposes or geometric limitations. Limitations may include slope of existing revetments and depth to toe of slope for minimum berth draft and maintaining adequate fairway widths with respect to walkway dock widths.

### Berthing System Layout Characteristics

#### Channel and Fairway Dimensions

	Width (feet)	Dredge Depth (feet MLLW)
<b>Entrance Channel</b>	75	-12 feet
<b>Interior Channels</b>	75	-12 feet
<b>Fairways</b>	1.75 * L <sub>B</sub> without side-ties	-12 feet
	1.50 * L <sub>B</sub> with side-ties	-12 feet

Note: L<sub>B</sub> = length of berth – based on longest berth in fairway

**TABLE 3**

#### Minimum Berth Depth

Berth Length (feet)	Dredge Depth (Feet MLLW)
<45	-10 feet
46 - 55	-10 feet
56 - 65	-10 feet
>65	-10 feet

Note: Slope of existing revetments and depth to toe of slope may require variance in minimum berth draft

**TABLE 4**

# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## Minimum Unobstructed Dock Widths

- Marginal Walkways 8 feet
- Main Walkways 6 feet
- Finger Floats See Table 5

## Minimum Double Berth and Finger Float Widths

Nominal Length (feet)	Berth Width (feet)	Finger Float (width)
30	23.0	3.0
35	26.0	3.0
40	27.0	4.0
45	29.0	4.0
50	30.0	4.0
55	31.0	4.0
60*	16.0	4.0
61 – 79*	18.0	5.0
>80*	18.5	6.0

Note: \* denotes single berths (>60 foot length)

TABLE 5

## Mooring Attachments

Tie down cleats will be provided to properly secure berthed vessels. The minimum number will be two cleats on a side of a fingerfloat and one on the main walkway per berth.

## Guide Piles

A sufficient number of floating dock guide piles will be provided to maintain position of the berthing system for design lateral loads due to environmental conditions. The profile height and length of the vessels will be used to determine a windage area for calculation of wind loads. Consideration shall be given to the maximum design combination of forces that can occur at the site as defined by the California Department of Boating and Waterways Guidelines. Pile cutoff elevation will likely be +14.0 feet MLLW. Pile tip elevation will be determined by soils conditions and requirements for lateral load capacity. All piles will be capped with an appropriate device to prevent the roosting of birds.

## Floating Dock System

The type of construction of the floating dock system has not been determined. Consideration will be given to use of wood, aluminum or concrete systems. The type of system best suited to the particular site may be determined by consideration of the initial cost and aesthetics. The initial construction cost and the life cycle cost of the competing systems will be considered in the selection.

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All types of dock systems will be engineered to withstand identical loading conditions and meet appropriate performance standards. Design parameters are presented in Table 6 below.

### FLOATING BERTH DESIGN PARAMETERS

Design Wave Height	2.0 feet
Commercial Vessel Displacement for impact	$25 * L_B^2$
Berthing Velocity Impact	1.0 ft/sec
Vertical Loads: <ul style="list-style-type: none"> <li>• Live Loads (distributed)</li> <li>• Live Load (concentrated)</li> </ul>	25 psf 400 lbs
Maximum Dock Freeboard (dead load only)	24 inches
Minimum Freeboard (dead load + live load)	10 inches
Minimum Design Service Life	30 years

Note:  $L_B$  = length of berth

**TABLE 6**

### Gangways and ADA-Accessible Ramps

The gangways and brows providing access to the floating dock system will have a minimum width of 3 feet between handrails. Design live load will be 100 pounds per square foot. The brow walking surface should have a non-skid surface treatment.

### GANGWAYS AND ACCESS PIERS

Access Piers – Design Live Loading	50 lbs/ft <sup>2</sup>
Gangways – Uniform Live Loading	100 lbs/ft <sup>2</sup>
Minimum Clear Width - Gangways	36 inches
Minimum Handrail Height – Gangways	34 inches
Maximum Handrail Height - Gangways	36 inches
Maximum Gangway Slope	3:1 (not less than 90% of the time)
Maximum Slope - Accessible Gangways	1:12*

Note: If gangway length is greater than 80 feet, 1:12 max slope does not apply.

**TABLE 7**

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## Utilities

Water service will be provided on the floating dock system. One standard 3/4-inch hose bib with backflow preventer will be furnished for each berth to deliver potable water.

## Fire Protection

A fire protection system conforming to the requirements of the San Francisco Fire Marshall will be provided. The system should include wet standpipes with 100 feet of hose in clearly marked fire cabinets on all main walkways. Spacing of the cabinets should be such that two hose lines could reach every berth in the harbor. Each cabinet should also contain a portable fire extinguisher. In order to furnish minimum fire flows (500 gallons per minute at 200 psi) it will be necessary to provide standpipe inlet connections accessible to fire vehicles to permit pressurization of the dock water system by fire department pumping equipment. Therefore, the water system design should allow for such high pressures and provide suitable backflow prevention devices to protect the city's water system.

## Electrical Service

### **Electrical Design Criteria**

Electrical power may come from the dock storage bins at each berth, and power pedestals may be used for transient berths only. Consideration will be given to the future anticipated load requirements of the berthed vessels. Generally, each berth will have its own power supply, except for the 70 foot though 90 foot berths which will have dedicated pedestals. Digital electronic metering will be provided within the power supply for each slip, with radio transmittal of meter outputs. In addition to power receptacles, each marine pedestal may contain telephone and high-speed internet outlets for each slip.

Electrical service will be provided to each berth. The size of the service depends on berth length as given in Table 8 below. Consideration should be given to metering or adjusting slip rental rates to reflect energy consumption by individual berthers. Consideration may also be given to ground fault protection for personnel and equipment, although such protection is not presently required by electrical codes, and does imply additional liability for the marina operator. The electrical distribution system will be a 480 volt system with step down transformers on the floating dock system, each serving about 100 berths. Consideration may be given to a review of the code requirements on marina load factors in order to achieve greater economy of feeder design. The dock storage bin providing service to each berth will be weatherproof, containing circuit breakers and receptacles of the locking and grounding type.

New electrical service will be provided by one or two PG&E above-grade, pad-mounted transformers with 12.47 kV primaries and 480/277 volt, three-phase

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secondaries. The new transformer(s) may be located near the Saint Francis Yacht Club and/or near the northwest corner of the Marina Green. Electrical service will be brought to the new floating docks via buried conduit. The conduit will be in shallow (about 2.5 to 3 feet deep) trenches that will be excavated in the existing pavements, sidewalk, and lawn areas around the site.

The new electrical service will be fed from the new buried conduit at some of the ramp locations to supply new 480 volt – 208Y/120 volt step-down transformers that will be mounted on the floating walkways. The float-mounted transformers will feed 208Y/120 volt, 3-phase, 4-wire panelboards containing circuit breakers protecting the power pedestal circuits. Approximately seven of the float-mounted transformers will be used to supply new power to the 300 plus boating berths. Each berth will either have its own electrical center/outlets or will share one with an adjacent berth.

### GENERAL POWER REQUIREMENTS FOR DIFFERENT SIZE BOATS

Sail and power boats to 30 feet in length	Single 30 amp, 125 volt receptacle
Sail and power boats – 30 feet to 40 feet	Two, 30 amp, 125 volt receptacles
Sailboats – 40 feet to 50 feet	Two, 30 amp, 125 volt receptacles
Powerboats – 40 feet to 50 feet	Two, 30 amp, 125 volt receptacles or one 50 amp, 125/240 volt receptacles
All boats 50 feet to 80 feet	Two 50 amp, 125/240 volt receptacles
All boats 80 feet to 90 feet	One 100 amp, 125/240 volt single phase outlet
85 feet to 100 feet plus	Two 100 amp, 125/240 volt single phase outlet

TABLE 8

#### **Dock and Access Gate Lighting**

Dock lighting will be low level to minimize glare, yet will provide effective walkway illumination. In general, dock lighting is incorporated in the dock power pedestal. In the event that the general public is permitted access to the floating dock

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system, overhead lighting and higher levels of illumination may be considered in those areas.

Access gate lighting may be solar-powered with a back-up battery system.

### 4.8 BREAKWATERS

Design parameters for the breakwater structures are presented in Table 9 below.

- 1-year significant wave height limit for head seas: 12”
- 50-year significant wave height limit for head seas: 24”

#### BREAKWATER PRELIMINARY DESIGN PARAMETERS

		Outer Segment (floating)	Inner Segment (fixed)
Length	(ft)	300	150
Elevation Top	(ft-MLLW)	-	10
Significant Wave Height	(ft)	3.6	2.7
Peak Wave Period	(sec)	4.0	4.0
Extreme Tides; High ; Low	(ft-MLLW )	+9.0	+9.0
	(ft-MLLW )	-2.5	-2.5
Public Access cap beam		-	No
Access Width	(ft)	-	-

TABLE 9

### 4.9 MAINTENANCE DREDGING

The proposed improvements requires a limited amount of dredging to remove sediments that have accumulated in the inner and outer West Harbor basins and provide project design depths for safe navigation and berthing of vessels as specified in Table 4 above.

The design dredge depth for the entrance channel and fairways will be -12 feet MLLW and -10 feet for the berth areas. These depths may not be achievable adjacent to the west mole, Marina Blvd. and James Fair seawalls, North Jetty and Saint Francis Yacht Club, due to the existing revetment slopes.

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## 5. GEOTECHNICAL CRITERIA

All geotechnical criteria for conceptual design are based on a site investigation and subsequent report provided by the geotechnical sub-consultant (AGS Geotechnical Study, 2009).

### 5.1 GEOTECHNICAL CHARACTERISTICS

The existing soil conditions are based on preliminary results from the site investigation. These results indicate soft clay (bay mud) approximately 25 to 35 feet thick underlain by 50 to 65 feet thick, loose to medium dense clayey and silty sand layer. The sand layer was underlain by stiff to very stiff clay and silt with varying amount of sand layer to maximum depth of explorations in Borings B-1 and B-2. Bedrock consisting of shale was encountered approximately 97 feet below the mudline.

This section discusses potential impacts related to seismic and geologic hazards, including ground shaking and associated secondary effects, coastal erosion, and offsite sedimentation. This section also discusses potential effects on the adjacent Fort Mason structures. The project site is located in an area that would be subject to strong ground shaking, potential liquefaction, and seismically-induced deformations in the event of a major earthquake on the San Andreas or Hayward faults. The high water table and unconsolidated sediments and fill materials in the vicinity can amplify ground shaking and result in liquefaction and settlement, which can cause considerably more structural damage than would be experienced by a building placed on materials such as bedrock or more consolidated sediments. During future earthquakes, liquefaction could damage one or both of the marina seawalls.

Prior investigations have been conducted on behalf of the City and County of San Francisco to evaluate the potential for liquefaction to occur within the Marina District and to predict the effects of liquefaction on the Fair's Seawall and the Marina Boulevard Seawall. The studies concluded that it would not be economically feasible to construct ground improvements to reduce liquefaction effects in large areas, and that ground improvements behind the Fair's Seawall would be required only if the goal were to reduce settlement in the entire Marina Green. Instead, ground improvements could be applied in strategic areas, such as near underground utilities, to reduce the effects of liquefaction at a given location. However, even with improvements, the seawalls could be damaged by area wide lateral spreading during a magnitude 7.9 or greater earthquake. The reports state that the City could choose to repair the seawall, utilities, and sidewalk/jogging path behind the seawall after an earthquake. The investigations discussed above indicate the potential for the seawalls to move and settle in the event of a major earthquake on the San Andreas or Hayward faults. The proposed project would not significantly alter the seawalls, nor would this existing area wide risk be substantially worsened by the proposed project.

# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## 5.2 LIQUEFACTION POTENTIAL

The liquefaction potential of the soil due to seismic loading is expected to be high for the purposes of the design of new, laterally-loaded guide piles. This potential will be further addressed in the subsequent geotechnical report.

Soil liquefaction is a phenomenon in which saturated (submerged) cohesionless soils lose their strength due to the build-up of excess pore water pressure, especially during cyclic loadings such as those induced by earthquakes. In the process, the soil acquires mobility sufficient to permit both horizontal and vertical movements if not confined. Soils most susceptible to liquefaction are loose, clean, uniformly graded, fine-grained sands such as those encountered at the site. Silty and clayey sands may also liquefy during strong ground shaking.

The liquefaction potential of soils at the site was evaluated using a simplified, analytical, and empirical procedure that is correlated with the liquefaction behavior of saturated sands during historic earthquakes (Youd, 2001; and Idriss and Boullanger, 2008). The primary data utilized in the analysis consisted of standard penetration test (SPT) and modified California (MC) sampler blow counts, which were obtained from the three borings drilled at the site. The SPT and MC blow counts recorded in the field were corrected for various factors to obtain corrected N-values, which were used in the liquefaction analysis. The factors used to obtain corrected N-values, included the effects of overburden pressure, rod length, sampler type and size, and fines content.

Based on the results of the liquefaction analysis, the West Harbor Marina site is considered to have a high potential for liquefaction.

The main effects of liquefaction at the site include settlement of the ground surface and utilities, lateral deformation, development of excess pore water pressure, buoyancy effects on the below groundwater structures, loss of allowable bearing pressure, and increased lateral pressures on utilities and foundations extending below the groundwater table.

The geotechnical engineer estimates that settlements up to 25 inches may occur during seismic events and that lateral deformation up to 3 feet may occur during seismic events.

Consideration will be given during preliminary design to allow for lateral movement of seawalls at access gangway attachment location. The access landing for the head of the gangways will be designed as a separate pile-supported structure with a closure plate at the seawall to allow for lateral movement of the seawall without damaged to the access landing or gangway.

# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## 6. FUNCTIONAL CRITERIA

Functional design criteria apply for this project and consist of the items below.

### 6.1 TYPE OF CONSTRUCTION

In general, new renovation components should be of concrete, timber, steel or fiber reinforced polymer (FRP) construction. Epoxy coated reinforcement may or may not be used. New piles should be precast and/or pre-stressed concrete, timber, steel or FRP.

### 6.2 FLOATING DOCKS

The floating docks will support dead loads consisting of utilities, access gangways and landing platforms. Vessels will be moored to the floating docks. The floating docks will also have electrical power and lighting. Floating dock construction may consist of timber, concrete, steel or aluminum. All float modules will be held in position by guide piles. Float flotation will be provided by foam-filled plastic pontoon. Floats will be vendor designed in accordance with a performance specification included with the Criteria Package.

### 6.3 MOORING SYSTEM – GUIDE PILES FUNCTIONAL DESIGN BASIS

#### **Floating Dock Guide Piles**

The floating docks will be fixed in position by cantilever guide piles, more or less evenly spaced. Pile material will most likely be of precast, prestressed concrete, steel pipe with an epoxy coating, treated timber or fiber reinforced polymer (FRP).

Pile-soil interaction.....per geotechnical recommendations

Factor of safety (lateral soil capacity, normal operating loads) ..... 2.0

Factor of safety (bearing piles, normal operating loads) ..... 3.0

One-third decrease in factor of safety for extreme load conditions.

#### **Pile Guide System**

The cantilever guide piles will require a connection between the floats and the piles. The pile guide system to be used will be a roller guide system designed to provide smooth, vertical movement and transfer horizontal forces. The rollers will be comprised of polymer plastic to reduce noise impacts.

# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## 7. DESIGN LOAD CRITERIA

Design load criteria for the West Harbor Marina improvements will include determination of loading of the structures. Loads will consist of dead (self-weight), live (transitory) and environmental (wind, wave and current), vessel or boat impact

The breakwater structures will be designed for wave loads with a 50-year return period.

The improvements will be designed for governing design load combinations per the requirements of the 2007 CBC. This includes in-service loads consisting of operating (normal) and extreme storm loads, and seismic loads.

Normal or operating design conditions are those that are expected to occur frequently during the life of the structure. Examples are stillwater conditions and annual storms consisting of maximum wave, current and wind load.

### 7.1 SAFETY FACTORS

Design analysis for the West Harbor Marina renovation will consider safety factors in the design of the improvements. Safety factors will be derived and developed as recommended in relevant building codes and design standards using sound engineering judgment.

# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## 8. MATERIALS

### 8.1 STRUCTURAL STEEL

#### 8.1.1 Structural Members

Structural steel for primary and secondary structural members may be mild, intermediate or high strength steel, as required by design. Hot-rolled Z-sections are envisioned for the sheet pile bulkhead.

Acceptable steels for design of substructure or top side members are:

ASTM A36 (Fy=36 ksi)  
ASTM A572 Grade 50 (Fy=50 ksi)  
ASTM A900 Grade 50 (Fy=50 ksi)  
API 5L X (Fy=42ksi)

All carbon steel member design will assume 36 ksi yield stress material unless dictated otherwise by design. All structure stainless steel member design shall be Type 316 and will assume 25 ksi yield stress material unless dictated otherwise by design.

#### 8.1.2 Welding

All structural welds shall be complete penetration welds unless fillet welds are justified by design and are indicated on the drawings.

#### 8.1.3 Bolts

Bolts shall be A325 carbon steel or Type 316 stainless steel. Specification should be per ASTM F1554.

### 8.2 CONCRETE

Concrete may be cast-in-place reinforced, pre-cast reinforced or pre-cast pre-stressed. Concrete and any associated reinforcement shall meet the following minimum requirements:

Material density: 150 pcf  
28-day minimum compressive strength: 5,000 psi cast-in-place

Maximum water-cement ratio (by weight): 0.40

Reinforcement: ASTM A 615 (Fy=60 ksi) and epoxy coated per ASTM A 775. ASTM A706 for welded rebar.

## WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

All concrete structures exposed to seawater shall have a minimum concrete cover to primary reinforcement of 3 inches.

Concrete mix shall be Type II with a maximum water/cement weight ratio of 0.40. All concrete structure exposed to seawater shall have an entrained air content between 4.5 and 6.0 percent.

### 8.3 ALUMINUM

Aluminum used for access gangway fabrication and other components shall be 6061-T6, 6063-T6, or per manufacturer's specification and approved by Engineer.

Bolts for use with structural aluminum shall be Type 316 stainless steel or per manufacturer's specification and approved by Engineer.

# WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

## 9. APPURTENANCES

### 9.1 CORROSION PROTECTION

Corrosion protection for steel structure shall be provided by cathodic protection and/or coating or galvanizing systems. Where appropriate, cathodic protection shall consist of aluminum or zinc manganese anodes attached to the steel pile structures. The corrosion protection system shall be based on the structure design life.

### 9.2 FENDERS AND MOORING COMPONENTS

Float fenders and cleats will be required. These items will be sized for the maximum length and displacement of vessels moored at the floats.

### 9.3 ACCESS

Access to the floating berths shall be considered as a part of the preliminary design. Typically, aluminum ramps will be used for access from the seawalls to the docks. The ramps will have a minimum of 36 inches clear distance between the handrails and shall have non-skid surfaces. Additionally, ADA-accessible ramps will meet current standards for clearance and handrailing dimensions and slope.

### 9.4 SECURITY GATES

Security gates will be provided on the access landings to the gangways. The gates will be accessed with key card or keypad coded system and will be ADA compliant by using a push bar. Although not impenetrable, the gates must be an adequate deterrent for theft, vandalism and access by unauthorized persons. The slip leaseholders will have a reliable means of entry and exit from their vessels.

### 9.5 HAND RAILS

Hand rails will be provided on ramp/gangway structures.

### 9.6 NAVIGATION AIDS

Navigation lighting will be required on the breakwater structures in accordance with U.S. Coast Guard requirements. Shore power may be used on the detached segments, however alternatives include shore power, solar or batteries unless impractical or unsafe.

## WEST HARBOR MARINA RENOVATION PROJECT DESIGN CRITERIA

### 10. REFERENCES

1. American Society of Civil Engineers, "Minimum Design Loads for Buildings and Other Structures," ASCE/SEI 7-05, 2006.
2. California Building Standards Commission, "2007 California Building Code (CBC)," California Code of Regulations, Title 24, Parts 1 and 2, 2007.
3. AGS, Inc., "Geotechnical Study – West Harbor Marina Improvement Project, San Francisco, California," 2009.
4. Coast and Harbor Engineering, "Coastal Engineering Analysis and Conceptual Design, San Francisco Marina West Yacht Harbor Renovation," 2009.
5. International Code Council, "2006 International Building Code (IBC)," latest edition.
6. City and County of San Francisco, "San Francisco Building Code," 2008.
7. Winzler & Kelly, "West Harbor Marina Condition Survey", September 2009.