



ALAMEDA COUNTY, CALIFORNIA

PROJECT # PRWWF 24-002
SPECIFICATION # 32400202

Berkeley Water Transportation Pier Ferry Project

BASIS OF DESIGN

PREPARED FOR SUBMITTAL TO:
ENGINEERING CRITERIA REVIEW BOARD
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT
COMMISSION
375 BEALE STREET, SUITE 510
SAN FRANCISCO, CA 94104
JANUARY 2026



CITY OF BERKELEY

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DRAFT

1 SUMMARY

1.1 Project Scope

The following describes the Basis of Design (BoD) for the Berkeley Water Transportation Pier Ferry (BWTPF) Project, which is to partially replace the existing Municipal Pier in Berkeley, CA. The project consists of the following elements:

Waterside:

- A pile supported pier 22ft wide by 1080 ft long,
- A canopy structure along a portion of the pier
- A 15ft wide by 300 ft long breakwater
- Two ferry landings. The ferry landings consist of steel float, fenders, mooring hardware, aluminum boarding ramp system, guide piles, donut fenders, aluminum gangway, access platform and security gates systems. Note one ferry landing will be constructed initially. The second landing may be added at a future date.
- Electrical, mechanical, and fire protections systems on the pier and ferry landings.

Landside:

- Landside site improvements include renovation of the existing parking lot for ferry users; street improvements at Seawall Drive (with new pavement, safety striping for vehicle, bicycle, and pedestrian crossings, and stormwater bioswales to treat stormwater) and at University Ave (with new layover pullouts for public buses and shuttles, drop-off zone for shuttles, rideshares, and family vehicles safety striping for vehicles, bike lanes, and pedestrian crossings to the ferry terminal); and the renovation and expansion of the existing plaza at the pier abutment. Also included will be renovation of pedestrian pathways and amenities, including safety lighting, new restroom; erosion repair on east side of south cove parking lot, and landside electric vessel charging infrastructure.

1.2 Existing Conditions

1.2.1 Topographic Survey

Topographic survey of the site was conducted in August 2024 by Mountain Pacific Surveys.

1.2.2 Bathymetric and Lidar Survey

Bathymetry data for the site was produced by eTrac Engineering Inc, a Woolpert Company. For COWI. Survey data was collected on July 24, 25, 27 and 29, 2024. Plotted on August 22, 2024

1.2.3 Shore Protection

The existing rip rap slope at the pier ferry terminal was installed at an unknown date. Visual inspection conducted in 2024 by COWI confirmed the existing rip rap slope is in reasonable conditions. See report A272767 BWTPF Project – Shoreline Protection Review for details.

1.2.4 Geotechnical Conditions

Project geotechnical findings and recommendations by ENGEO are provided in Appendix A.

1.3 Project Datum

The project datum is described as follows:

- Vertical data shall reference City of Berkeley MLLW (hereafter referred to as MLLW); Vertical Control Point # 13, Elevation 19.96'¹
- Horizontal data shall reference NAD83, SPCS California Zone 03. Horizontal control Point # 13 2144146.431'N, 6036359.948'E

Conversions:

- EL 0.0 NAVD88 = +0.57 feet MLLW².

1.4 Water Levels

1.4.1 Tidal Datum

Water levels were retrieved from the Berkeley tidal gauge (ID 9414816), which is the closest station to the project site, and reference information provided by the National Oceanic and Atmospheric Administration (NOAA) benchmark sheet. Table 1 presents the water levels recorded at the station which form the basis for our project site. Tidal data is per NOAA averages based on the 1983-2001 tidal epoch.

Note: MLLW values below refer to City of Berkeley MLLW vertical datum, values differ from the NOAA MLLW. This project adopted the City of Berkeley datum and refers to it as “MLLW” throughout this document.

Datum	Value NAVD88 (ft)	Value MLLW (ft)	Description
HAT	+7.8	+8.4	Highest Astronomical Tide, on 12/23/2003 18:42
MHHW	+6.2	+6.8	Mean Higher-High Water
MHW	+5.6	+6.2	Mean High Water
MSL	+3.4	+4.0	Mean Sea Level
NAVD88	0.0	+0.6	North American Vertical Datum of 1988
MLLW	0.1	0.7	Mean Lower-Low Water
LAT	-2.1	-1.6	Lowest Astronomical Tide, on 06/04/2008 14:06

Table 1-1 - Tidal reference levels at Berkeley, CA 9414816

1.4.2 Extreme Water Levels

A study done by AECOM (San Francisco Bay Tidal Datums and Extreme Tides Study) in 2016 updated and expanded the USACE 1984 study of tidal datums and extreme tides for San Francisco Bay. The study modelled and presented detailed extreme tide information for the entirety of the Bay shoreline. Table 1-2 reproduces the extreme tide elevation for point ID 519, coinciding with the Berkeley Pier.

Return Period (years)	Extreme Tide Elevation (ft – NAVD88)	Extreme Tide Elevation (ft – MLLW)
1	7.4	8.0
10	8.5	9.0
50	9.3	9.9
100	9.7	10.3

¹ eTrac, 2024, Memo – Vertical Analysis Between NOAA MLLW and City of Berkeley MLLW

² eTrac, 2024, Memo – Vertical Analysis Between NOAA MLLW and City of Berkeley MLLW

Table 1-2 - Extreme Tide Elevation – ID 519 (AECOM, 2016)

The extreme water level considered for this project is 10.3 ft MLLW, with a return period of 100 years (1% Annual Exceedance Probability)

1.4.3 Sea Level Rise

For the BWTPF project, a design life of 50 years has been established, placing its planning horizon around the year 2075.

The 2024 California Sea Level Rise Guidance integrates the advancements in sea level rise science, including refinements in climate models, improved ice-sheet dynamics understanding, and better regional projections, drawing from the most recent IPCC’s Sixth Assessment Report (AR6) and the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC).

The projection for the San Francisco gauge has been conservatively selected with the Intermediate Scenario to define the Sea Level Rise Allowance (SLR), as shown in Table 1-3.

A SLR vulnerability assessment for the structures up to the end of the century and for higher emission scenarios (intermediate-high and high) is presented in Coastal Study and Appendices Report.

Condition	Station	Scenario	SLR Allowance (ft)
Design Life 2075	San Francisco	Intermediate	1.6

Table 1-3 - Projection FEMA/NOAA and California Coastal Commission Sea Level Rise Policy Guidance 2024 Update for San Francisco.

1.4.4 Design Still Water Level

The Still Water Level at the project location is shown in Table 1-4. This elevation excludes waves and waves impacts, but includes astronomical tides, storm surges and sea level rise for the design life of the project.

Parameter	Elevation	Elevation
	(ft-NAVD88)	(ft-MLLW)
Extreme Water Level (1% AEP)	9.7	10.3
Sea Level Rise Allowance	1.6	1.6
Design Still Water Level	11.3	11.9

Table 1-4 Design Still Water Level

2 GOVERNING CODES AND REFERENCE DOCUMENTS

2.1 Codes and Standards

The following codes, specifications, regulations and industry standards, where applicable, shall cover the main design and material for the structures and other related items:

Principal General Design Standard:

1. Accessibility Standard for Pedestrian Facilities in the Public Right-of-Way (PROWAG) 2024
2. ASCE 61, Seismic Design of Piers and Wharves, American Society of Civil Engineers, 2014 (ASCE 61-14)
3. ASCE 7, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, 2022 (ASCE 7-22).
4. ABS, American Bureau of Shipping and Affiliated Companies, Rules for Building and Classing Steel Barges, 2024
5. Alameda Countywide Clean Water Program; C.3 Stormwater Technical Guidance, May 19, 2024 (Version 8.2)
6. Alameda County Hydrology & Hydraulics Manual
7. Berkeley Stormwater Requirements Checklists
8. California Regional Water Quality Control Board San Francisco Bay Region Municipal Regional Stormwater NPDES Permit, Order No. R2-2022-0018 as amended by Order No. R2-2023-0019, NPDS Permit No. CAS612008 (May 11, 2022)
9. CBC, California Building Code, California Building Standards Commission, 2022 (2022 CBC Vol 1 & Vol 2)
10. Caltrans Standard Specifications 2025 Edition
11. Caltrans Standard Plans 2025 Edition
12. Layout and Design Guidelines for Marina Berthing Facilities, California Department of Boating and Waterways, Boating Facilities Division, July 2005
13. Unified Facilities Criteria, UFC 4-151-01 Design: Pier and Wharves
14. Unified Facilities Criteria, UFC 4-159-03 Design: Moorings, June 16, 2016

In situations where the above standard does not cover a particular design situation the applicable design practices and guidelines may include, but are not limited, to the following:

1. ACI 318-19 (22), Building Code and Commentary for Structural Concrete, American Concrete Institute, 2019 (ACI-318-19(22))
2. ACI 315-18, Manual of Standard Practice for Detailing Reinforced Concrete
3. ACI 357.2R-10 America Concrete Institute, State of the Art Report on Floating and Float-In Concrete Structures, FARMINGTON FILLS, MT
4. AISC, Steel Construction Manual 16th Ed. 2023

5. ACI 543, Design, Manufacture and Installation of Concrete Piles, American Concrete Institute, 2012 (ACI PRC 543R-12)
6. AISC 360, Specification for Structural Steel Buildings, American Institute of Steel Construction, 14th edition, 2022 (AISC 360-22)
7. API Recommended Practice 2A-WSD, 22nd Edition
8. ASTM Standards, Various, American Society for Testing and Materials International (ASTM).
9. AWS D1.1, Structural Welding Code – Steel, American Welding Society, 2020 (AWS D1.1:2020)
10. AWS D1.2, Structural Welding Code – Aluminum, American Welding Society, 2014 (AWS D1.2:2014)
11. IBC, International Building Code, International Code Council, 2021 (IBC 2021) NDS, National Design Specification for Wood Construction ASD/LRFD, 2024 edition, and National Design Specification Supplement, Design Values for Wood Construction, 2024 edition (2024 NDS).
12. PIANC International Navigation Association A.D. 1885 Guideless for Design of Fender System (2024) WG 211.
13. PCI Design Handbook: Precast and Prestressed Concrete, 8th edition, Prestressed Concrete Institute, 2017
14. US Access Board Proposed Passenger Vessel Accessibility Guidelines, June 25, 2013

2.2 Reference Documents

The following documents contain reference information for the project.

1. Feasibility Study, Ferry Facility at Berkeley Municipal Pier, by GHD, Inc, Concord, Dated June 30, 2023.
2. Berkeley Water Transportation Pier Ferry Project, Condition Hydrographic Survey & Aerial Lidar Survey, by eTrac Inc., a Woolpert Company, Dated August 2024.
3. San Francisco Bay Tidal Datums and Extreme Tides Study, AECOM, 2016
4. State of California Sea Level Rise Guidance, 2024 Science and Policy Update

3 GENERAL REQUIREMENTS

3.1 Function

3.1.1 Typical Function

Pier

The pier is expected to be accessible to the public 7 days a week. The pier will have a gate at the shoreside end of the pier to allow for closure of the pier after hours as necessary. The pier is intended to be used by pedestrians and emergency vehicles.

Ferry Landing

The ferry landing is expected to have vessel operations seven (7) days a week, but not 24 hours a day. The landing will be serviced by vessels operated by WETA. The ferry landing will consist of a queuing area along the shore, a covered pier, an aluminum gangway, aluminum boarding system, steel float, guide piles to hold the float in place, and donut fenders. The landing will extend parallel to the pier and provide boarding on each side of the float.

Americans with Disabilities Act (ADA) codes and standards must be applied in the design of the ferry landing's passenger boarding system (gangway, float, ramps, and platforms). The design will be in accordance with U.S. Access Board "Proposed Passenger Vessel Accessibility Guidelines", dated June 25, 2013.

3.1.2 Emergency Function

Pier and Ferry Landing(s) – Risk Category IV - Essential Facility

Since WETA is responsible for coordinating and providing ferry transportation in response to emergencies or disasters affecting the Bay Area transportation system, the landing(s) will be designed for use as a staging area for first responders and evacuation by ferry in the event of a catastrophe. For this reason, the ferry landing shall be designed as an essential facility, CBC Risk Category IV.

Breakwater – Risk Category 2 - Normal Facility

The breakwater is not required for post disaster emergency response and is designed as Risk Category 2 facility.

3.2 Location

The Project site (see Figure 3-1) is located in Berkeley Marina, West on the intersection of Seawall Drive and University Avenue.

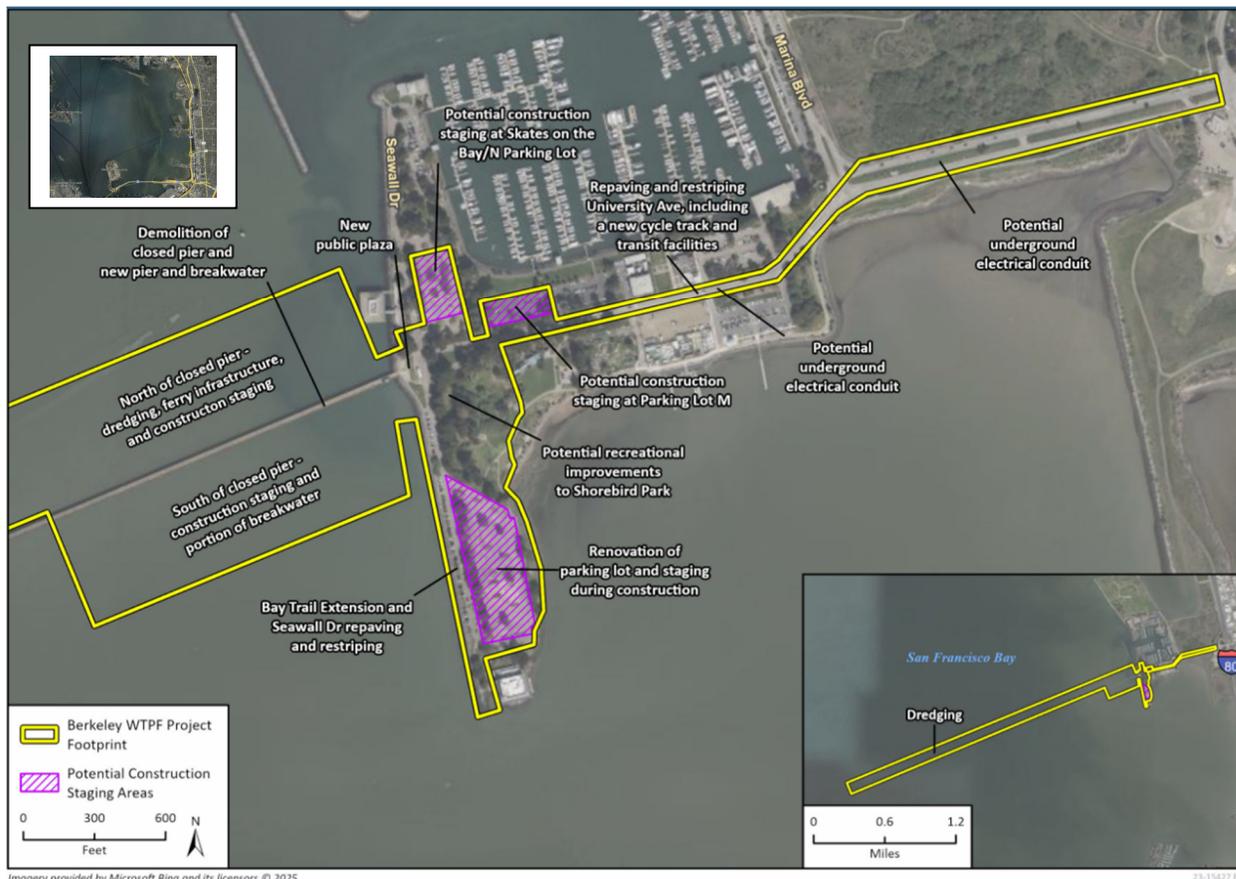


Figure 3-1 - Site Location and Project Footprint

3.3 Design Life

The planned design life for the project will be as follows:

- Pier/Breakwater (all components) = 50 years
- Ferry Landing (all components) = 50 years

The above design life assumes that a regular inspection and maintenance program is implemented to repair damage and deterioration.

3.4 Units

All drawings and calculations will be provided in English units as follows:

- Length: Feet and/or inches
- Force: Kips or pounds
- Time: Seconds and/or minutes/hour/days/months/years
- Temperature: Degrees Fahrenheit

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

4 LOADS AND LOAD COMBINATIONS

4.1 Dead Loads (D)

Dead load is comprised of the self-weight of the structure (i.e., weight of permanent structure, reinforced concrete, structural steel and timber).

4.1.1 Unit Weights

The following unit weights shall be used in the calculations:

- Reinforced concrete: 150 lb/ft³ (normal weight)
- Reinforced concrete: 90-115 lb/ft³ (light weight)
- Structural steel: 490 lb/ft³
- Cast iron: 450 lb/ft³
- Aluminum alloys: 175 lb/ft³
- Timber (untreated): 45 lb/ft³
- Timber (treated): 50 lb/ft³
- Asphalt concrete: 150 lb/ft³
- Seawater: 64 lb/ft³

4.2 Live Loads (L)

Live loads are non-environmental loads on the structures, which are not permanently in place.

4.2.1 Pier

- Uniform (LU), 250 psf
- Concentrated (LC), vehicle loading AASHTO HL-93

The pier will be subject to AASHTO HL-93 (fire truck) loading. Truck wheel loads will be calculated in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specification for Highway Bridges, per Figure 4-1.

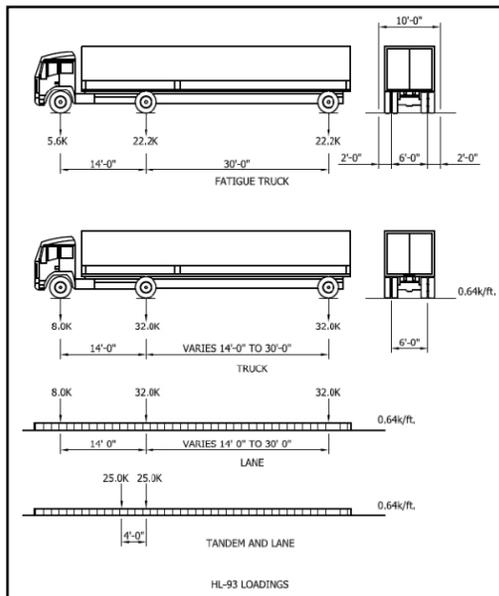


Figure 4-1 - AASHTO HL-93 Loads

4.2.2 Breakwater

- Uniform (LU), 250 psf
- Concentrated (LC), vehicle loading AASHTO H15-44

Breakwater will be subject to AASHTO H15-44 GVW 15 Tons (ambulance/maintenance truck) loading. Truck wheel loads will be calculated in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specification for Highway Bridges. The intersection between the breakwater and the fixed pier will be designed for the higher HL-93 fire truck loads shown in the pier section.

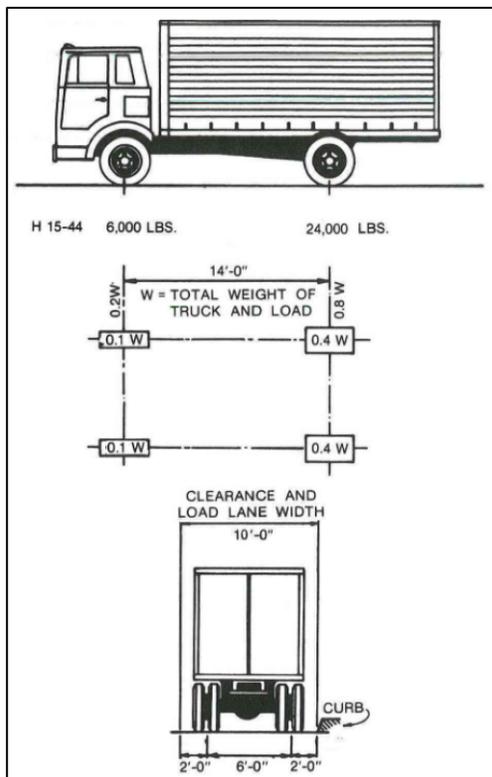


Figure 4-2 – AASHTO H15-44 Loads

4.2.3 Ferry Landing: Access Platform, Gangways, Walkway System, and Float

- Uniform Live Load (LU):

Access Platform Deck	250 psf
Gangway	100 psf
Float Pedestrian Walking Area	100psf
Float Deck	
o 40 psf for the structural design of the deck plating, beams, and connections of deck/ beams to frames, bulkheads, or walls	
o 0 psf (no uniform live load) applied to the deck for floating stability, draft, freeboard, heel, trim, sagging forces, hogging forces, or float torsion calculations	

- Concentrated Live Load (LC)

Access Platform Deck	AASHTO H15-44
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All others 650 lbs
 For pier deck, LC is concentrated over an area 2.5 ft by 2.5 ft, applied at any point on the deck. For gangways, LC is concentrated over a 6" by 6" area applied at any point on the gangway. For float-mounted ramps and platforms, LC is concentrated over a 4.5" by 4.5" area applied at any point on the platforms. For floats, LC is concentrated over a 12" by 12" area applied at any point.

- Maximum deflection for gangways shall not exceed $L_{span}/360$.
- Marine Growth load of 5 psf shall be applied on submerged surfaces below MLLW

4.2.4 Gate/Railing

- Uniform (LU), horizontal or, 50 lb/ft
- Uniform (LU), vertical or, 100 lb/ft
- Concentrated (LC), horizontal or vertical 250 lbs

4.2.5 Stairs

- Uniform Live Load (LU) 100 psf
- Concentrated Live Load (LC), on one thread 300 lbs

4.2.6 Ladders

- Concentrated (LC), horizontal (rungs) 300 lbs
- Concentrated (LC), rails extending above platform (any direction) 100 lbs

4.2.7 Landside Area

- Uniform (LU), 250 psf
 - Concentrated (LC), vehicle loading AASHTO HL-93
- Landside area, including the ferry plaza and parking lot, will be subject to AASHTO HL-93 (fire truck) loading. Truck wheel loads will be calculated in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specification for Highway Bridges.

4.2.8 Plaza Railing

- Uniform (LU), horizontal or, 50 lb/ft
- Uniform (LU), vertical or, 100 lb/ft
- Concentrated (LC), horizontal or vertical 250 lbs

4.2.9 Utility Loads

The pier, access platform, gangway, float and fixed pier to be designed for weight of permanent utilities hung or placed on or under the deck.

4.3 Roof Live Load (L_r)

Loads pertain to canopy are designed in accordance with ASCE 7-22. Loads on the canopy are 59.45psf and act perpendicular to the canopy surface.

4.4 Buoyancy (Hydrostatic) Loads (B)

Hydrostatic pressures shall consist of uplift forces applied at the rate of 64 psf for every foot of submergence below water level.

4.5 Berthing Loads (Be)

The energy (E_B) to be absorbed by fenders at berthing impact is referred to as the berthing energy. This energy will be determined using the kinetic energy method in accordance with PIANC WG33 Guidelines for Design of Fender Systems (2002) for the design vessel:

- $E_B = \frac{1}{2} \times W/g \times V_B^2 \times C_M \times C_B \times F_A$ where,
 - E_B = Energy to be absorbed by fender system during berthing (k-ft)
 - W = Displacement of a design vessel (kips)
 - g = Acceleration of gravity = 32.17 ft/s²
 - V_B = Berthing velocity of the vessel (ft/sec)
 - C_M = Added mass coefficient, for catamarans or single-hulls as applicable, per MOTEMS/ PIANC = 1.35 to 2.38
 - $C_B = C_E C_G C_D C_C$
 - C_E = Eccentricity coefficient per MOTEMS/ PIANC = 0.52 to 0.57
 - C_G = Geometric coefficient $\equiv 1.0$
 - $C_D = C_S$ = Deformation / softness coefficient $\equiv 1.0$
 - C_C = Berth configuration coefficient $\equiv 1.0$
 - F_A = Accidental factor for abnormal conditions = 1.0 for this project, which closely resembles existing projects

4.5.1 Vessel Berthing Design Conditions

- Vessel Speed = 1.5 ft/sec
- Incident Angle = 10 degrees
- Berthing Point on Vessel = L/4 (quarter point)

4.5.2 Donut Fender Berthing Design Conditions

- Vessel Speed = 1.2 ft/sec
- Incident Angle = 10 degrees
- Berthing Point on Vessel = L/4 (quarter point)

4.5.3 Design Vessels

Ferry Vessels

The ferry landing shall be designed for WETA's San Francisco Bay Ferry Fleet of vessels. (PENDING INFORMATION FROM WETA ON NEW ELECTRIC DESIGN VESSELS PARAMETERS).

4.6 Current Loads (C)

The design surface current speed is 1 knot.

The force, F_C , on the vertical faces of the float due to this current velocity is calculated per:

- $F_C = \frac{1}{2} \times C_D \times A \times \rho/g \times V^2$ where
 - F_C = Static Transverse Current Force
 - C_D = drag force coefficient
 - A = area [ft²] of the vertical face on which the current is acting
 - ρ = 1.99 slugs/ft³ for seawater
 - g = 32.2 ft/sec²
 - V = current velocity

4.7 Earth and Hydraulic Pressures on Retaining Structures (H)

Static earth pressures shall be considered in the design of the abutment along the shoreline, if applicable. Lateral earth pressures due to seismic forces shall be considered in the design of the retaining structures.

Hydraulic pressures due to water level differentials, resulting from tidal fluctuations and/or groundwater accumulations shall be considered in the design of retaining structures, if applicable.

4.8 Seismic Loads (EQ)

4.8.1 Pier and Breakwater

Seismic design of the pier and ferry will follow the displacement-based method described in ASCE 61-14. As the ferry landing pier is an "essential" facility that needs to be operational after a seismic event, the seismic performance criteria used for design is more stringent than the design classification "High" as described in ASCE 61-14 Section 2.2.1. As there is no clear guidance for essential facilities in ASCE 61-14, a more rigorous criteria were developed, see Table 4-1. The breakwater is designed as Risk Category Medium as defined in ASCE 61-14. Pseudo-Spectral Acceleration for the various earthquake are included in Table 4-3. 5%, 7% and 10% Damped spectra were provided for the CLE earthquake. Structure Damping values were calculated using ASCE 61-14 section 6.6.3.3.

Operating Level Earthquake (OLE)	50% in 50 years (72-year return period)	No damage
Contingency Level Earthquake (CLE)	10% in 50 years (475-year return period)	Minimal Damage
Design Earthquake (DE)	Design Earthquake per ASCE 7	Minimal Damage
Maximum Considered Earthquake (MCE)	MCE Earthquake per ASCE 7	Controlled and Repairable Damage

Table 4-1 – Pier Performance Criteria (Risk Category Essential)

Operating Level Earthquake (OLE)	N/A	N/A
Contingency Level Earthquake (CLE)	20% in 50 years (224-year return period)	Controlled and Repairable Damage
Design Earthquake (DE)	DE per ASCE 7	Life Safety

Table 4-2 – Breakwater Performance Criteria (Risk Category Medium)

PERIOD (seconds)	PSEUDO-SPECTRAL ACCELERATION (g)				
	OLE (72-year)	CLE (225-year)	CLE (475-year)	DE (ASCE7-05)	MCE (ASCE 7-05)
0.01	0.25	0.41	0.54	0.57	0.85
0.02	0.24	0.41	0.53	0.57	0.85
0.03	0.25	0.41	0.53	0.56	0.85
0.05	0.27	0.45	0.58	0.62	0.93
0.08	0.34	0.55	0.72	0.77	1.16
0.10	0.41	0.66	0.85	0.91	1.36
0.12	0.46	0.73	0.93	0.98	1.47
0.15	0.52	0.82	1.05	1.00	1.50
0.20	0.58	0.93	1.18	1.00	1.50
0.25	0.62	1.00	1.28	1.00	1.50
0.30	0.63	1.05	1.35	1.00	1.50
0.40	0.60	1.04	1.38	1.00	1.50
0.50	0.57	1.01	1.35	1.00	1.50
0.60	0.51	0.93	1.25	1.00	1.50
0.75	0.43	0.81	1.13	0.80	1.20
1.00	0.35	0.70	1.00	0.60	0.90
1.50	0.24	0.51	0.75	0.42	0.63
2.00	0.18	0.40	0.60	0.32	0.47
3.00	0.11	0.26	0.40	0.20	0.30
4.00	0.07	0.18	0.29	0.15	0.23
5.00	0.05	0.13	0.21	0.12	0.18
7.50	0.03	0.07	0.11	0.08	0.12
8.00	0.02	0.06	0.10	0.08	0.11
10.00	0.02	0.04	0.06	0.06	0.09

Table 4-3 – Pseudo-Spectral Accelerations (5% DAMP)

PERIOD (seconds)	PSEUDO-SPECTRAL ACCELERATION (g)		
	CLE 5% Damped (475-year)	CLE 7% Damped (475-year)	CLE 10% Damped (475-year)
0.01	0.54	0.54	0.53
0.02	0.53	0.53	0.53
0.03	0.53	0.53	0.52
0.05	0.58	0.56	0.54
0.08	0.72	0.67	0.63
0.10	0.85	0.79	0.72
0.12	0.93	0.85	0.77
0.15	1.05	0.94	0.85
0.20	1.18	1.05	0.93
0.25	1.28	1.14	1.00
0.30	1.35	1.20	1.05
0.40	1.38	1.22	1.07
0.50	1.35	1.20	1.04
0.60	1.25	1.12	0.97
0.75	1.13	1.00	0.86
1.00	1.00	0.88	0.76
1.50	0.75	0.67	0.58
2.00	0.60	0.53	0.46
3.00	0.40	0.36	0.31
4.00	0.29	0.26	0.22
5.00	0.21	0.19	0.17
7.50	0.11	0.10	0.09
8.00	0.10	0.09	0.08
10.00	0.06	0.06	0.06

Figure 3 - 5%, 7%, 10% CLE Damped Spectra

No Damage Strain Limits

Pier structure is to remain elastic.

Minimal Damage Strain Limits

Pier structure to meet "Minimal Damage" requirement per ASCE 61-14 Table 3-1

Table 3-1. Strain Limits for “Minimal Damage” per Section 2.4.3

Pile type	Component	Hinge location		
		Top of pile	In ground	Deep in ground (>10D _p)
Solid concrete pile	Concrete	$\epsilon_c \leq 0.005$	$\epsilon_c \leq 0.005$	$\epsilon_c \leq 0.008$
	Reinforcing steel	$\epsilon_s \leq 0.015$		
	Prestressing steel		$\epsilon_p \leq 0.015$	$\epsilon_p \leq 0.015$
Hollow concrete pile ^a	Concrete	$\epsilon_c \leq 0.004$	$\epsilon_c \leq 0.004$	$\epsilon_c \leq 0.004$
	Reinforcing steel	$\epsilon_s \leq 0.015$		
	Prestressing steel		$\epsilon_p \leq 0.015$	$\epsilon_p \leq 0.015$
Steel pipe pile	Steel pipe		$\epsilon_s \leq 0.010$	$\epsilon_s \leq 0.010$
	Concrete	$\epsilon_c \leq 0.010$		
	Reinforcing steel	$\epsilon_s \leq 0.015$		

^aIf the interior of the hollow pile is filled with concrete, all strain limits shall be the same as for solid piles.

Controlled and Repairable Stain Limits

Pier structure to meet "Controlled and Repairable Damage" requirement per ASCE 61-14 Table 3-2.

Table 3-2. Strain Limits for “Controlled and Repairable Damage” per Section 2.4.2

Pile type	Component	Hinge location		
		Top of pile	In ground	Deep in ground (>10D _p)
Solid concrete pile	Concrete	$\epsilon_c \leq 0.005 + 1.1\rho_s \leq 0.025$	$\epsilon_c \leq 0.005 + 1.1\rho_s \leq 0.008$	$\epsilon_c \leq 0.012$
	Reinforcing steel	$\epsilon_s \leq 0.6\epsilon_{smd} \leq 0.06$		
	Prestressing steel		$\epsilon_p \leq 0.025$	$\epsilon_p \leq 0.025$
Hollow concrete pile ^a	Concrete	$\epsilon_c \leq 0.006$	$\epsilon_c \leq 0.006$	$\epsilon_c \leq 0.006$
	Reinforcing steel	$\epsilon_s \leq 0.4\epsilon_{smd} \leq 0.04$		
	Prestressing steel		$\epsilon_p \leq 0.020$	$\epsilon_p \leq 0.025$
Steel pipe pile	Steel pipe		$\epsilon_s \leq 0.025^b$	$\epsilon_s \leq 0.035$
	Concrete	$\epsilon_c \leq 0.025$		
	Reinforcing steel	$\epsilon_s \leq 0.6\epsilon_{smd} \leq 0.06$		

^aIf the interior of the hollow pile is filled with concrete, all strain limits shall be the same as for solid piles.

^bIf the steel pipe pile is infilled with concrete, a value of 0.035 may be used.

4.8.2 Kinematic Loading

Kinematic loads are mitigated by using a 36” steel pipe that slots over the 24” structural steel pipe. The intent of the 36” pipe is to accommodate the kinematic displacements without exerting force on the 24” Structural steel pile.

4.8.3 Pier Canopy Structure

The pier canopy is a non-building structure that is supported by another structure and shall be designed Per ASCE 7-22.

4.8.4 Ferry Landing

4.8.4.1 Gangway

Seismic load shall be determined as per ASCE 7-22, Chapter 15.

4.8.4.2 Float and Guide Piles

Earthquake loads are not considered in the design of these structures.

4.9 Wind Loads (W)

4.9.1 Extreme Wind Speed

Long term wind data is available for NOAA Station 9414750 Alameda, and 9414290 San Francisco. Short term data is also available for approximately 12 years for NOAA Station 9414847 Point Potrero.

Local wind data measurements for the Berkeley Marina (approximately five years) and Reef Light (less than two years).

The design parameters shown in *Table 4-4* derived from statistical analysis of the Alameda Station data.

Return Period (years)	Wind Speed (knots)	Wind Speed (mph)
10	35	40.3
50	39.8	45.8
100	42	48.3

Table 4-4 – Extreme Wind Conditions – Alameda Station

4.9.2 Wind Loads on Pier, Canopies, and other structures

Pier and canopies are classified as Open Structures and shall be designed to resist wind loads computed in accordance with ASCE 7-22.

- Basic Wind Speed (3-s gust) V 105 mph
Basic wind speed is used for design of pier and canopy framing for strength and canopy cladding and its connections to steel framing and corresponds to approximately a 3% probability of exceedance in 50 years (Mean Return Interval = 1,700 years).

Wind Design Parameters:

- Risk Category IV

- Exposure Category D
- Topographic Factor, K_{zt} 1.0
- Directional Factor, K_d 0.85

Deflection Criteria for Canopy

- Components and Cladding shall be designed for worst-case deflection resulting from pressures derived using basic wind speed

4.9.3 Wind Loads on Floats

Maximum three-second ultimate (LRFD) gust speed for mooring and berthing of ferries against float: 40 mph (Combined with other loads for design of mooring bits, spring line lugs, guide piles, and guide pile collars.)

4.10 Wave Loads (W_a)

Numerical modelling of the wave conditions was performed using Spectral Wave (SW) module of the MIKE 21 modelling suite from DHI, Denmark. MIKE 21 SW is a third-generation time-dependent spectral wind-wave model based on unstructured meshes. It simulates the growth, propagation, decay, and transformation of wind generated waves and swells in offshore and coastal areas. The wave model was simulated for a continuous period of 27-years (January 1997-December 2023) and was used to extract wave parameters at the breakwater location.

Another numerical model was applied for modelling of the wave propagation into the terminal. MIKE 21 BW is a Boussinesq type non-linear wave model, which simulates in the time domain the properties of propagation of irregular, directional waves into the terminal considering all the important effects like shoaling, depth refraction, diffraction, bottom friction, non-linear wave-wave interaction, frequency and directional dispersion, partial and full reflection, and transmission through porous structures.

The results of the wave disturbance modeling were combined with the long-term wave conditions outside the breakwater (results from the SW model). This was done by establishing transfer functions, describing the transformation of wave heights from outside the breakwater to any given point sheltered by the breakwater (pier, plaza), and then combining the transfer functions with the long-term series of wave conditions. This provides a long-term time series of the wave heights at selected locations, for subsequent statistical analysis.

The design operational and extreme wave height were calculated using Weibull and Gumbel statistical distributions, both methods involve fitting the distribution parameters to historical wave height modeled data.

See Coastal Study and Appendices Report for wave modeling and extreme value analysis details.

4.10.1 Operational Wave Conditions

The operational condition represents the wave conditions that is expected to occur with a return period of one year. This condition is used to define the typical upper limit for safe and efficient operations, such as navigation, loading, and construction activities. *close to Berth 2

Table 4-5 shows the operation conditions at the breakwater and pier location.

Location	Operational Wave Conditions	
	Hs (ft)	Tp (s)
Breakwater	2.0	3.0
Pier*	1.4	3.0

*close to Berth 2

Table 4-5 – Operational Wave Conditions - significant wave height (Hs) and Peak Period (Tp)

4.10.2 Extreme Wave Conditions

The extreme wave condition corresponds to the design sea state associated with a 100-year return period.

Table 4-6 shows the operation conditions at the breakwater, pier, and plaza location.

Location	Extreme Wave Conditions	
	Hs (ft)	Tp (s)
Breakwater	2.6	3.2
Pier	1.8-2.3	3.2
Plaza	2.4	3.2

Table 4-6 – Extreme Wave Conditions - significant wave height (Hs) and Peak Period (Tp)

4.10.3 Wake Waves

Provided that the site does not have any other port or terminal nearby, wakes should not have a significant effect on the ferry terminal operability. Moreover, because of the existing regulations regarding the maximum allowable navigation speed when ferries approach the landing, it is expected that shipping traffic will generate wakes up to 1 foot.

4.10.4 Sagging and Hogging

The ferry landing float must be checked for sagging and hogging in the long and short directions using a sinusoidal wave with trough to crest dimension equal to float depth but not more than six (6) feet and wavelength equal to float length (for the long direction) or float beam (for the short direction).

4.11 Mooring Line and Breasting Loads (M)

Mooring and breasting loads are to be calculated for the design vessel at the float under wave, wind, and current loading.

Ferry float fender lugs will be designed for 76 kips between any horizontal angle from 5 to 31° with respect to a line parallel to the long direction of the ferry float and 0 to 30° from horizontal.

Float bitts will be designed for 50 kips (ASD) in any horizontal direction combined with a 35 kips (ASD) vertical load.

4.12 Creep/Shrinkage/Thermal Loads (R+S+T)

4.12.1 Creep/Rib Shortening (R)

Creep (also referred to as rib shortening) is a material-specific internal load particular to prestressed concrete. The pier deck will not be prestressed and creep can be ignored. Creep of prestressed concrete piles is negligible and will be ignored.

4.12.2 Shrinkage (S)

Beams and decks, which are constructed from concrete components, are subject to forces resulting from shrinkage of concrete during the curing process. The new concrete decks will include temperature and shrinkage reinforcement as required by ACI 318-19.

4.12.3 Thermal Loads (T)

The effects of thermal forces, resulting from fluctuations in temperature, will be considered. The temperature range for the proposed location shall be as follows, in accordance with the AASHTO Standard Specifications for Highway Bridges, 17th.

Material	Total Design Temperature Range (AASHTO Procedure B)
Steel	30 to 120°F
Concrete	40 to 115°F

Where thermal expansion and contraction causes frictional forces, the following friction coefficients shall be used:

Steel to steel:	0.30
Concrete to concrete	0.80
Steel to UHMW	0.20
Concrete to Steel	0.40
Timber to steel	0.50

4.13 Load Combinations

4.13.1 General

The ferry landing shall be proportioned to resist the load combinations represented in this section. Each component of the structure shall be designed to withstand all load conditions that are applicable. Components shall also be checked for serviceability (i.e., creep, fatigue and crack control as described in ACI 318) and for temporary loads. The following load conditions represent various combinations of loads and forces to which the facility may be subjected. Load combinations below are derived from the 2016 CBC and UFC 4-152-01.

The following load/force combinations are listed in tables and should be assembled as an equation as follows:

$$U_i \text{ or } S_i = f_D (D) + f_L (LU \text{ or } LC) + f_B (B) + f_{Be} (Be) + f_C (C) + \dots \\ f_H(H) + f_{EQ} (EQ) + f_w (W+Wa) + f_M (M) + f_{RST} (R+S+T)$$

U_i = Ultimate load combination

S_i = Service load combination

f_x = Load factor listed in tables below

The following load acronyms are applicable for the load combinations below.

D, DL	Total Dead Load
LU	Uniform Live Load
LC	Concentrated Live Load
Lo	Unreduced Uniform Roof Live Load
Lr	Reduced Uniform Roof Live Load
I	Impact Load (for LC only)
B	Buoyancy Loads

Be	Berthing Loads
C	Current
H	Horz. load due to lateral earth, ground water or pressure of bulk material.
E, EQ	Combined effect of horizontal and vertical earthquake loads
E _{h1} , E _{h2}	Earthquake actions in the respective principal horizontal direction
k	50% of Peak Ground Acceleration (PGA)
k'	0.7k = (0.7)(0.5)PGA = 35% of PGA
W	Wind Load on Structure
Wa	Wave Load on Structure
M	Mooring/Breasting Load (Wind, wave, current of float/vessel)
R	Creep / rib shortening
S	Shrinkage
T	Temperature load

4.13.2 Load Resistance Factor Design

Load combinations and load factors used for load factor design are presented in Table 4-7. The following load conditions represent various combinations of loads and forces to which the facility may be subjected. Each component of the structure shall be designed to safely withstand all load conditions that are applicable. They shall also be checked for serviceability (i.e., creep, fatigue, and crack control as described in ACI-318, and temporary loads.

Table 4-7 - LRFD Load Combination

CBC Equation	16-1	16-2	16-2	16-2	16-4	16-3	16-5	16-7
UFC Equation	U0	U1	U2	U3	U4	U5	U6	U7
D ^a	1.4	1.2	1.2	1.2	1.2	1.2	1.0+k	1.0-k
LC+I or LU	–	1.6	–	1.6	–	1.6	0.1	–
B	1.4	1.2	1.2	1.2	1.2	1.2	1.2	0.9
Be	–	–	1.6 ^b	–	–	–	–	–
C	–	–	1.2	1.2	1.2	1.2	–	–
H ^c	–	1.6	1.6	1.6	1.6	1.6	1.0	1.0
EQ ^d	–	–	–	–	–	–	1.0	1.0
W+Wa	–	–	–	–	1.0	–	–	–
M	–	–	–	–	–	1.6	–	–
R+S+T	–	–	–	1.2	–	–	–	–

- 0.9 (0.6 ASD) for checking members for min axial load and max moment.
- Accidental Berthing: 1.2 support structure, 1.0 fender system components.
- Where the effect of H resists the primary variable load effect, a load factor of 0.9 (0.6 ASD) shall be included with H where H is permanent and H shall be set to zero for all other conditions.
- Effects of simultaneous seismic excitation in orthogonal horizontal directions shall be considered using eqs: $\pm 1.0 E_{h1} \pm 0.3 E_{h2}$ and $\pm 0.3 E_{h1} \pm 1.0 E_{h2}$

4.13.3 Allowable Stress Design Load Combinations

Where working stress design is used, structures and portions thereof shall resist the most critical effects resulting from the combination of loads below (see Table 4-8). The load combinations shall also be used for designing and checking vertical foundation capacity and long-term vertical deck loading, such as dead load deflection.

Table 4-8 - ASD Load Combinations

CBC Equation	16-8	16-9	16-10	16-10	16-12	16-9	16-12	16-16
UFC Equation	S0	S1	S2	S3	S4	S5	S6	S7
D ^a	1.0	1.0	1.0	1.0	1.0	1.0	1.0+k'	1.0-k'
LC+I or LU	–	1.0	–	1.0	–	1.0	0.1	–
B	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6
Be	–	–	1.0	–	–	–	–	–
C	–	–	1.0	1.0	1.0	1.0	–	–
H ^d	–	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EQ ^e	–	–	–	–	–	–	0.7	0.7
W+Wa	–	–	–	–	0.6	–	–	–
M	–	–	–	–	–	1.0	–	–
R+S+T	–	–	–	1.0	–	–	–	–

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5 OPERATIONAL REQUIREMENTS

5.1 Pier

- Top of Pier @ Landside End = +16.50 feet MLLW
- Top of Pier @ 100ft from Shore to Waterside End = +17.60 feet MLLW
- Concrete floor framing shall be limited to long term deflections of L/360. Long term deflection is the deflection due to the effects of creep and shrinkage after the attachment of nonstructural elements.
- Public gate- Pair of large swing gates (19'-0" wide x 10'-6" tall) that consist of square steel HSS member and flat plate infill pickets; galvanize finish. A personnel outswing gate is set within the south gate leaf for use during emergency access when the public gate is closed. The public gate is to always remain in the open position except for during an emergency when it will close and locked.
- Two Ferry gate entrances- 8'-6" tall by 4'-0" wide pair of swing gates and fence that consist of square steel HSS members and flat plate infill pickets; galvanize finish, setback 4 feet from edge of pier deck on concrete landings that lead to the gangways.
- Guardrails- 48" tall guardrail that consists of round HSS steel railing, shaped flat plate posts and solid round steel rods for in-fill pickets; maximum 4" gap in between pickets; galvanize finish. Hand railing with stainless steel finish contains LED handrail point lighting aimed at deck. This fixture will also be used for emergency egress lighting.
- Pier deck amenities:
 - Fish cleaning station- located at the far west end of the pier and will have one ADA compliant stainless-steel table, an ADA compliant stainless-steel sink and a standard stainless-steel sink for public use.
 - 60" bench bolted to pier deck. Type and quantity TBD.
 - Metal trash receptacle bolted to pier deck. Type and quantity TBD.
 - Swivel seats for fishing at the pier end termination bulb-out (3) areas. Type and quantity TBD.

5.2 Canopies

Pier will have a canopy structure along a portion of its length to provide protection from the elements for queuing passengers. Canopy structure shall allow for a fire truck to pass by without impediment. The cantilevered and curved pier canopy is 16' wide that covers half the width of the pier and both ferry entry gates at each end of the canopy. It has a shallow "S" shaped profile with the high point at the center of the pier and sloping down towards the north side of the deck supported by a single row of columns on low side 12" from the edge of the pier deck.

- The canopy consists of a 7/8" thick x 24" wide translucent cellular polycarbonate panels secured to 2" x 3.5" aluminum curved frame mullion; clear anodized finish; supported by steel frame outriggers, round HSS purlins, beams and columns attached to the pier deck.

The canopy color is blue on both the exterior and interior side. The canopy steel frame will be painted white high-performance paint suitable for marine type environment.

- The canopy will have LED linear downlights attached to the roof purlins, wall sconces on the columns and electronic passenger destination signage.

5.3 Breakwater

- Top of Breakwater = +17.60 feet MLLW
- Breakwater will consist of precast concrete panels and concrete bather piles

5.4 Gangway

- Gangway will be aluminum.
- Gangway will be ADA compliant per Access Board, “Proposed Accessibility Guidelines for Passenger Vessels”, 2013)
 - The minimum clear width for a ramp is 102” including the handrails on each side.
 - The gangway shall be a minimum of 120 ft.
 - Gangway shall not exceed a slope of 1:12 for tides between MLLW and MHHW.

5.5 Ferry Landing

5.5.1 Steel Float

- The steel float will be 42-ft x 135-ft and will match WETA’s Universal Charging Float (Ref. WETA Downtown SF Terminal Universal Charging Float (UFC) Project Drawings dated 4/24/2024). For additional information on UFC, refer to Section **Error! Reference source not found.**
- Steel float is to have a design life of 50 years. The design life assumes regular maintenance of the steel float to replace anodes. During the design life of the steel float it is anticipated that the steel float will need to be removed from service and dry docked to repair/replace the coating. The frequency of the dry docking will be similar to other WETA steel floats currently in use.
- Zinc anodes shall be installed for the protection of the underwater hull area from corrosion. The anodes shall be installed in locations always submerged, and by bolting the ends of the steel straps to brackets attached to the hull steel. Epoxy coating shall be applied to exterior float bottom, sides, ends, and float interior area as specified in the project documents.
- Minimum Freeboard at Steel Float
 - The float shall have a nominal freeboard of 34 inches at the edge. Float to be checked for overtopping and stability with the proposed freeboard. The float shall have a fresh water ballasting system to adjust the freeboard to conform to Project requirements and adjust for trim. A nontoxic corrosion preventive admixture shall be used with the ballast water. A means of inspection to monitor each compartment of the float for leak detection will be provided.

5.5.2 Float Fenders

- Vertical Fenders shall extend a minimum of 7 feet above the deck of the float.
- Fenders type to be Arch Fender

5.5.3 Mooring Fittings

- Mooring fittings to be located to accommodate the full range of design vessels.
- Padeyes to be added to fender brackets.
- Mooring line guards to be included on fender brackets to prevent mooring lines from going under boarding ramps.

5.5.4 Ramps

- The boarding system ramps are to be aluminum.
- Ramps to be ADA compliant.
 - Maximum slope of fixed ramps 1:12.
 - Adjustable boarding ramps are to be designed to work for the range of design vessel boarding elevations while maintaining 1:12 slope.
 - Per ADA Rule 405.6 Rise: The rise for any ramp run shall be 30 inches maximum
 - The minimum clear width for a ramp is 48” including the handrails on each side.
- The boarding system to accommodate the vessel door spacing and height.
- Fifty foot spacing is specified between fore and aft ramps to line up with the door spacing on the WETA boats.
- Face of boarding ramps are to be set back from the fender line 12". Taper boarding ramp vertical member at waterside end to avoid interference with vessels.
- Ramps main operating controls will be hardwired type. Each ramp will have its own control station and pendant and these devices will be coded to limit access only to trained ferry system operators.
- Brow ramps to be provided for each boarding ramp (3 total). WETA to provide details for brow ramps.

5.5.5 Steel Piles

- The float will be designed to have 36” diameter steel guide piles Although, calculated design forces are expected to be lower, each guide pile collar, at a minimum, will be designed to resist a minimum force of 100 kips in any horizontal direction acting through the center of the pile, transmitted through the collar to the float.
- Steel piles to be coated and anodes for corrosion protection
- The steel piles will be designed for the following corrosion rates.
 - Atmospheric Zone 0.002 in per year – Top of Pile to 1 ft. above HAT

- Splash Zone 0.006 in per year – 1 ft. above HAT to MLLW
 - Immersed Zone 0.004 in per year – MLLW to mudline
 - Soil Embedded Zone 0.001 in per year – mudline to pile tip
- Corrosion rates based on California Department of Transportation (CalTrans) Corrosion Guidelines Version 3.2, May 2021.
 - The corrosion rates above are only applicable to the exterior surface of the steel pipe pile. The interior surface of the pile (soil plug side) will not be exposed to sufficient oxygen to support significant corrosion.
 - The piles are uncoated 10ft below the mudline.
 - The corrosion rates are applied for the unprotected years of steel corrosion.
 - Unified Facilities Criteria (UFC) 4-151-10, September 2001, Mod 1 September 2012, Table 5-1 "Period of Protection for Steel to be expected from Various Coating", the period of protection for a coal tar epoxy system with 15 to 20 mil thickness is between 10 and 20 years in a marine exposed environment. The pile protective coating is assumed to be effective for 15 years.
- Welds on steel pipe piles along the travel of the steel float to be grinded smooth prior to coating.
 - Fiberglass cones to be installed on top of each pile

5.5.6 Donut Fenders

- Fender to be located to protect the corners of the float and provide a pivot point for vessels entering and leaving the berth.
- The fender shall be free to rotate around the supporting pile and move up and down along the pile to accommodate the tide.
- Geometry
 - Type: Foam-Filled Donut
 - Donut Fender Diameter: 5.75 to 6.1 feet
 - Minimum Energy Absorption: 3.1 kip-ft. per foot
 - Maximum Reaction Force: 11.9 kips per foot
 - Flat Side Freeboard Height: 10'-0"
 - Overall Flat Side Height: 15'-0"
 - Overall Height: 16 feet approximately
 - Pile Size: 36-inch diameter
 - Fender Color: Black

6 MATERIAL PROPERTIES

6.1 Concrete

6.1.1 General

Concrete shall be in accordance with ACI 211.1 and ACI 301 capable of providing strength, durability, density and minimum chloride concentration. Design and Specifications shall have the goal to minimize concrete cracking.

Minimum Strengths for Concrete at 28 days

- | | |
|---|-----------|
| • General Site Concrete | 4,000 psi |
| • Pier and Breakwater Structural Concrete | |
| Deck | 5,000 psi |
| Steel Pipe Plug | 7,000 psi |
| • Prestress Concrete Piles | 7,000 psi |

6.1.2 Concrete Cover

- | | |
|---|--------|
| • Submerged, in tidal or splash zone | 3 in |
| • Cast against and exposed to earth | 3 in |
| • Formed and exposed to earth or weather: | |
| ○ No. 6 through No. 18 bars | 2 in |
| ○ No 5. bar, W31 or D31 wire or smaller | 1-½ in |
| • Above grade, formed, not exposed to earth or weather: | |
| ○ Slabs, walls, joists | 1-½ in |
| ○ Beams, columns | 1-½ in |

6.2 Reinforcing Steel

6.2.1 Mild Steel

- | | |
|------------------------------------|------------------------------|
| • Deformed mild bars | ASTM A615, Gr. 60 |
| • Welded deformed mild bars | ASTM A706, Gr. 60, Low Alloy |
| • Headed Welded deformed mild bars | ASTM A706, Gr. 80, Low Alloy |
| • Spiral reinforcement | ASTM A82, 70 ksi |

6.2.2 Prestressing Strands

Prestressing strands shall conform to ASTM A416 and have an ultimate tensile strength of 270 ksi. The strands shall not be epoxy coated. Jacking force shall be determined in accordance with manufacturer's stressing procedures and losses shall be determined in accordance with PCI.

6.3 Structural Steel

Structural steel shall meet the following minimum requirements unless noted otherwise:

- Float Guide & Donut Fender Pipe Piles ASTM A252 Gr. 3 modified for $F_y=60$ ksi
- Steel Structural Shapes: ASTM A992 or A572, Gr. 50
- Plates, Bars ASTM A992 or A572, Gr. 50
- Anchor Bolts ASTM F1554, Grade 55
- Threaded Rods ASTM A572, Grade 50
- High Strength Bolts ASTM F3125 Grade A325

All exposed steel shall be hot-dipped galvanized. Galvanizing process shall conform to ASTM A123 or ASTM A153 as applicable.

6.4 Welding

Welding of mild steel shall use E70XX Low Hydrogen electrodes and comply with AWS D1.1 unless noted otherwise. Aluminum filler metals and welding procedures shall comply with AWS D1.2.

6.5 Aluminum Alloy

All aluminum used in the fabrication shall be Alloy 6061-T6 or 6063-T6.

- Standard Structural Profiles ASTM B308
- Bars, Rods, Wires, Profiles and Tubes ASTM B221
Hot Extruded or Similar Methods
- Structural Pipe and Tube ASTM B429

APPENDIX A: GEOTECHNICAL REPORT & MEMORANDUMS

The geotechnical parameters shall be based on recommendations provided in the geotechnical reports and memorandums prepared by ENGEO including the following:

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