APPENDIX D-2

Sea Level Rise Technical Memo

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DRAFT

MEMORANDUM

To:	Matt Fennig, Vallejo Marine Terminal
From:	Neil Nichols, Christopher Devick, Dilip Trivedi
Date:	March 12, 2015
Subject:	Technical Memorandum Sea Level Rise Assessment M&N Project No: 8828

In support of the proposed improvements at Vallejo Marine Terminal (VMT), Moffatt & Nichol is performing an Initial Site Assessment as stated in Task 1 of the Scope of Work:

- Review of project plans, design basis and project description provided by the project team;
- Collection of available information on tidal datums and coastal climate related to wind waves, vessel wake, and extreme water levels from information available in the public domain and based on our experience in the area;
- Memorandum summarizing the collected information and provides an opinion on the risks associated with sea level rise at the proposed project. This memo will be a high level assessment appropriate for an EIR/CEQA document.

This Technical Memo documents information gathered and discusses sea-level rise issues related to proposed improvements for the VMT.

1. INTRODUCTION

The project site sits on the east bank of Mare Island Strait (Napa River) approximately ¾ of a mile north of its confluence with Carquinez Strait. The strait is a 400-ft wide navigation channel with adjacent depths varying from 25’ to 38’ below MLLW. An existing timber structure will be demolished and replaced with a new concrete platform structure and a new rock dike is proposed to extend northward with fill behind the dike to create new backlands for VMT operations. Figure 1 shows the project site in relation to Mare Island Strait and Carquinez Strait.

2. WATER SURFACE ELEVATIONS

The water level gauge located closest to the site is the 9415218 Mare Island Naval Shipyard, Carquinez Strait. This gauge is operated by the Center for Operational Oceanographic Products and Services (CO-OPS) of NOAA, and has verified hourly measured data from 2006 to 2012. Tidal datums from this gauge are presented in **Table 1**.

The six-year period of data from the Mare Island gauge is not long enough to estimate extreme water levels; at least fifteen years of measured water level data is generally needed to

adequately predict water levels for extreme events. Therefore, existing sources of data were reviewed to determine the 1% annual exceedance flood event, commonly called the 100-yr flood.

Figure 1: Project Vicinity Map

Table 1: Tidal Datum Elevations (Tidal Epoch 1983-2001)

TIDAL PLANE	MLLW (ft)	NAVD88 (ft)
HIGHEST OBSERVED WATER LEVEL (12/22/96)	7.71	8.07
MEAN HIGHER HIGH WATER (MHHW)	5.76	6.12
MEAN HIGH WATER (MHW)	5.19	5.55
MEAN TIDE LEVEL (MTL)	3.07	3.43
MEAN LOW WATER (MLW)	0.96	1.32
MEAN LOWER LOW WATER (MLLW)	0.00	0.36
NORTH AMERICAN VERTICAL DATUM 1988†	-0.36	0.00
LOWEST OBSERVED WATER LEVEL (6/6/12)	-2.01	-1.65

FEMA provides 100-yr flood elevations – defined as the Base Flood Elevation or BFE – as part of their National Flood Insurance Plan. The BFE is defined on Flood Insurance Rate Maps; the VMT falls within a Special Flood Hazard Area (SFHA) Zone AE with a BFE of 9' NAVD88 (note that that the FEMA BFE is rounded to the nearest foot).

Figure 2: Current FEMA Flood Insurance Rate Map (partial)

Recent analysis performed for Mare Island provides extreme water levels for various return periods; the results are not rounded to the nearest foot and are useful in accurately determining the anticipated level of flooding at VMT. The information is presented in **Table 2** below.

Table 2: Extreme Water Level Elevations (Mare Island) [1]

RETURN PERIOD (years)	STILLWATER LEVEL (ft, NAVD88)
2	8.01
5	8.27
10	8.48
25	8.74
50	8.95
100	9.15

3. WIND DATA

The recent studies at Mare Island also included gathering wind data from the Napa County Airport gauge, approximately nine miles north of the VMT. This study used data recorded from January 1994 to October 2013 and developed a wind climate for the Cullinan Ranch site, which is similar to the wind climate at the VMT. The annual wind rose, presented in **Figure 3**, depicts the wind speed and direction frequency data for the 19 year time period.

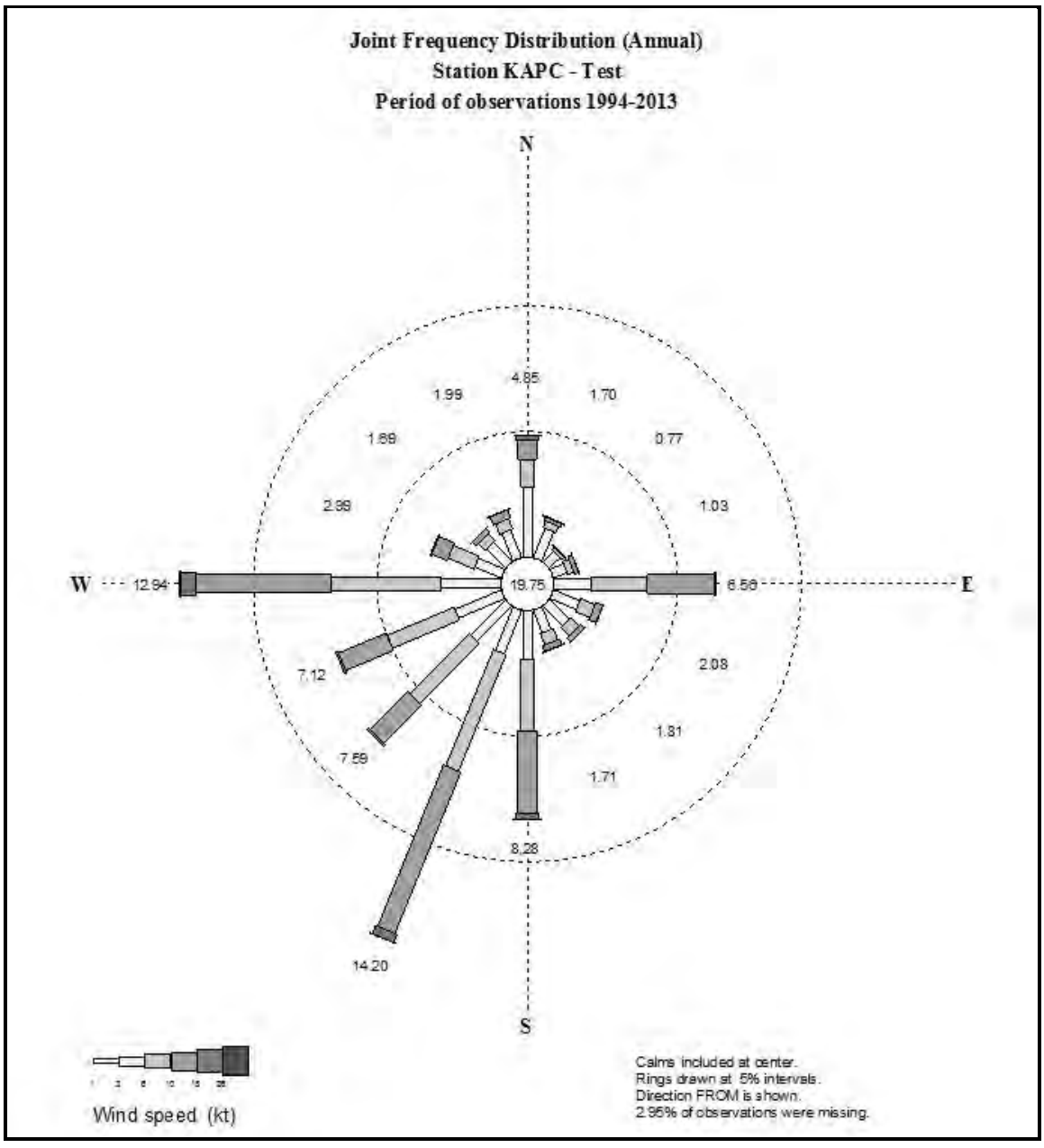

Figure 3: Annual Wind Rose, Napa County Airport [2]

4. WIND-GENERATED WAVES

Wind-generated waves occur when wind acts on the water surface over a distance; this is defined as the fetch. For the prevailing wind directions of West and Southwest, the fetch distances are short and the resulting waves are on the order of 1' to 1.5'. Winds from the South could potentially generate a slightly larger wave due to the longer fetch; however this is mitigated by the presence of shallow water and breakwaters extending out into Carquinez Strait.

5. VESSEL WAKES

Vessel wake generated by ferry vessels are likely the governing wave conditions in the area. We anticipate that vessel wake would be in the 1-ft range depending on vessel characteristics, speed and distance from the shoreline, and water depths within Napa River. Further analysis would be needed to confirm the vessel wake in the project vicinity.

6. SEA-LEVEL RISE

In March 2013, the Sea-Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) released their State of California Sea-Level Rise Guidance Document based on the recently published (June 2012) National Research Council (NRC) Sea-Level Rise for the Coasts of California, Oregon, and Washington[3]. **Table 3** summarizes the sea level rise (SLR) projections, including the low and high range values, for the San Francisco Bay area. Further, the CO-CAT guidance recommends that sea level rise values for planning be selected based on risk tolerance and adaptive capacity.

Table 3: Sea Level Rise Projections for San Francisco, California (NRC 2012 Report)

Time Period	Low	Projected	High
2000-2050	4.5"	11.0"	23.8"
2000-2070*	8.4"	18.5"	38.5"
2000-2100	16.5"	36.0"	66.0"

Interpolated based on City & County of San Francisco's SLR Guidance document (Appendix 4[4])

The Bay Conservation and Development Commission (BCDC) has recently approved two projects [5] within SF Bay based on the projected values for the 2050 and 2100 timeframes shown above.

7. FLOOD ELEVATION

The 100-yr return period flooding event can be the result of extreme tidal effects only, or a combination of extreme tides and waves. Based on the extreme water levels and minimal wave exposure, the facility is likely to be subjected to maximum flooding of approximately 9.45' NAVD88, as shown in **Table 4**:

Table 4: Likely Flooding Scenarios

Water Surface Condition	Water Surface Elevation (ft, NAVD88)	Wave Crest Height*	Flood Elevation (ft, NAVD88)
100-yr WSEL (stillwater)	9.15	0.0	9.15
50-yr WSEL + 1.0' Wave	8.95	0.5	9.45
10-yr WSEL + 1.5' Wave	8.48	0.75	9.23

* Based on a wave with half being above stillwater (crest) and half below (trough)

We recommend a flood elevation of 9.5' NAVD88 to be used as the basis of comparison for the proposed VMT facility.

8. EVALUATION OF PROPOSED FACILITY

Wharf Structure

The proposed facility is expected to have a top of deck elevation of 11.86' NAVD88 (11.50' MLLW). Based on the flooding elevations in Table 5, there will be 2.36' (28") of freeboard initially after construction. This accommodates all projections of SLR through 2050 shown in Table 3, and falls midway between the "projected" and "high" estimates of SLR for year 2070.

For planning purposes, we will focus on the "projected" SLR values. These values have been reasonable guides for policy determinations on recent relevant projects similar to the one proposed at VMT. To determine the number of years that 28" of freeboard can theoretically protect from SLR, we used the interpolation tool provided by CCSF's SLR Guidance document. The anticipated SLR that is estimated for year "t" (years after 2000) can be calculated by:

$$\text{SLR Projection (Most Likely, in)} = [0.000045t^3 + 0.00037t^2 + 0.428t]/2.54$$

Based on an initial freeboard of 28", the "t" is calculated as 88 corresponding to year 2088. This provides for 73 years of SLR from present day. This allowance for SLR is considered appropriate and reasonable based on our past experience and professional judgment.

The drawings we reviewed (see **Figure 4**[6]) indicate a superstructure that has a 2' thick deck over 2' deep pile caps. The outer edge of the platform has a 6.5' deep beam supporting the fender system. Due to their depths, the edge beam and pile caps are both extending below the 100-yr WSEL, and may be subjected to buoyancy/uplift forces during extreme tidal events. The edge beam will be submerged daily by high tides, and eventually (after SLR occurs) the pile cap will be as well. These structural members should thus be designed to resist these loads and for continual salt water submergence.

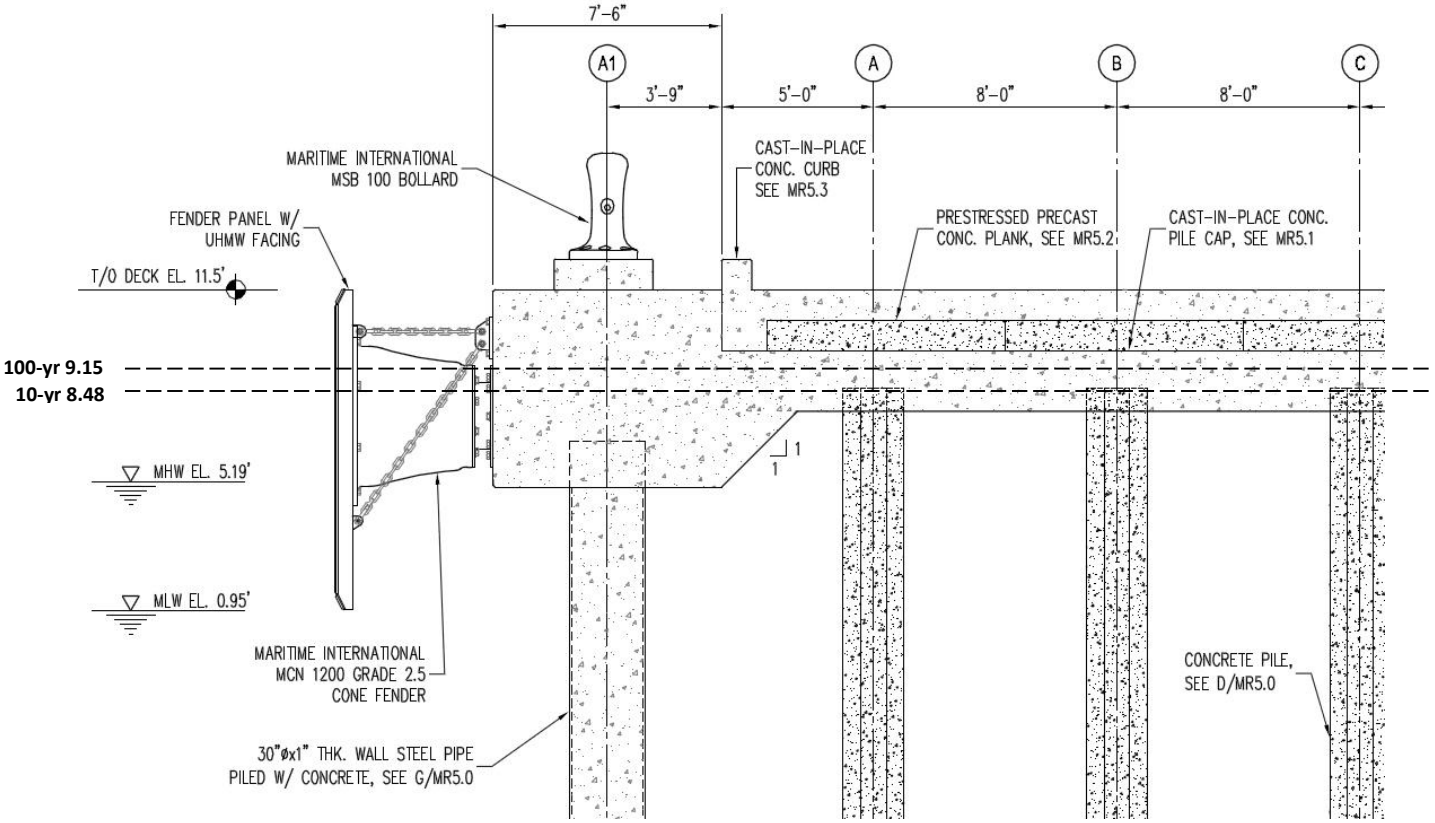

Figure 4: Proposed Platform Cross-Section

Diked Area

The diked portion of the facility faces northwest, and is potentially subjected to wind-generated waves and wakes. The short fetch will not allow formation of waves larger than the 1' to 1.5', so the proposed crest elevation of 11.86' NAVD88 (same as for the wharf structure) should be appropriate.

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[1] *"Cullinan Ranch Hwy 37 Inundation Study"*, Moffatt & Nichol, Feb 2014

[2] *ibid*

[3] "*Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future",* National Research Council, The National Academies Press, Washington, D.C., 2012

[4] "*Guidance for Incorporating Sea Level Rise Into Capital Planning in San Francisco – Assessing Vulnerability and Risk to Support Adaptation*," City and County of San Francisco Sea Level Rise Committee, Sept 2014

[5] Burlingame Point Development (Burlingame) and Blu Harbor Development (Redwood City)

[6] 90% Construction Drawings, McLaren Engineering Group, February 11, 2015