APPENDIX HWQ

San Francisco Bay Conservation and Development Commission (BCDC) Future Water Level Assessment

28 May 2021

Ms. Jan Werner
Marathon Petroleum
150 Solano Way
Pacheco, CA 94553

Project 217068 – BCDC Future Water Level Assessment, Marathon Avon Wharf, Martinez, CA

Dear Ms. Werner:

Simpson Gumpertz & Heger Inc. (SGH) conducted an evaluation of future water level elevations at the Marathon Avon (Avon) Wharf in Martinez, California. This document serves as guidance for future planning at the terminal and fulfills requirements in the San Francisco Bay Conservation and Development Commission (BCDC) Permit No. 2014.006.00 Article II, Section I. The scope of this study is the portion of the marine terminal permitted under the 2014 BCDC permit.

BACKGROUND

The following documents serve as a basis for this study:

- "Tesoro Avon Trestle Sea Level Rise Study" Prepared by Ben C. Gerwick, Inc., 3 February 2014.
- "Trestle and Pipeway Upgrade Drawings", Prepared by Ben C. Gerwick, Inc., 26 September 2014.
- San Francisco Bay Conservation and Development Commission (BCDC). BCDC Permit No. 2014.006.00, 23 July 2015.
- "Avon Wharf October 2015 Condition Survey Report", prepared by COWI North America Inc., 30 November 2015.
- "Revised Sea Level Rise Guidance, Waste Management Unit Closure, Units 10/11/14, 31 and 32", Prepared by Geosyntec Consultants, January 2017.
- Tesoro Avon Wharf – MOTEMS Initial Audit", prepared by COWI North America Inc. and Eichleay Inc., 19 May 2017.

Under Article II, Section I of BCDC Permit No. 2014.006.00, the terminal design cross beams for the pipeway must accommodate projected water levels through 2030. Additionally, the permittee (Marathon) is required to monitor water levels periodically with each MOTEMS Audit relative to the pipeway and pipelines. The water levels to be monitored include extreme tide, flood, and storm events. The permit presumes inundation of the pipelines and supporting structure is a risk

to safe terminal operations. BCDC requests water level data for the site be monitored and expected dates for when the cross beam may be vulnerable to inundation.

TRESTLE ELEVATIONS

SGH has used the survey data reported in the Trestle and Pipeway Upgrade Drawings to establish the elevations of the trestle pile cross beams referenced in the BCDC permit. This includes the portion of the trestle between Bents 22A and 168A.

Elevations of the cross beams vary along the length of the pipeway and trestle. Below are some key elevation changes along the trestle:

- Bent 22A: +12.50 ft MLLW
- Bent 39A: +11.86 ft MLLW
- Bent 48A: +10.63 ft MLLW
- Bent 54A: +9.74 ft MLLW
- Bent 72A: +8.58 ft MLLW
- Bent 165A: +8.58 ft MLLW
- Bent 167A: +16.92 ft MLLW

Elevation of the cross beams between the listed values are regularly sloped. Bents 72A to 165A are the low elevations of the pipeway and are the focus for this study. Bent 167A supports an expansion loop for the piping, hence the very high elevation. The cross beams have the capability of being raised in the future to provide more freeboard when necessary.

SOURCE DATA SETS

We obtained monthly data from the NOAA Tide and Metrological Observation Stations at Port Chicago (ID: 9415144) and Martinez-Amorco Pier (ID: 9415102). Avon is located approximately 2.8 miles downstream from the Port Chicago station and about 2.0 miles upstream from the Amorco station. Figure 1 shows the proximity of the NOAA stations with respect to the Avon site. The Port Chicago station provides monthly water level observations from November 1979 through April 2021, while the Amorco Pier has a shorter dataset from June 2013 through April 2021.

Both NOAA stations provide several water level metrics for each month available in the dataset; the observed water levels are as follows:

- Highest Observed Water Level
- Mean Higher High Water (MHHW)
- Mean High Water (MHW)
- Mean Sea Level (MSL)
- Mean Tide Level (MTL)

- Mean Lower Water (MLW)
- Mean Lower Low Water (MLLW)
- Lowest Observed Water Level.

Figure 2 and Figure 3 show the available metrics provided by the nearby NOAA Tide Stations.

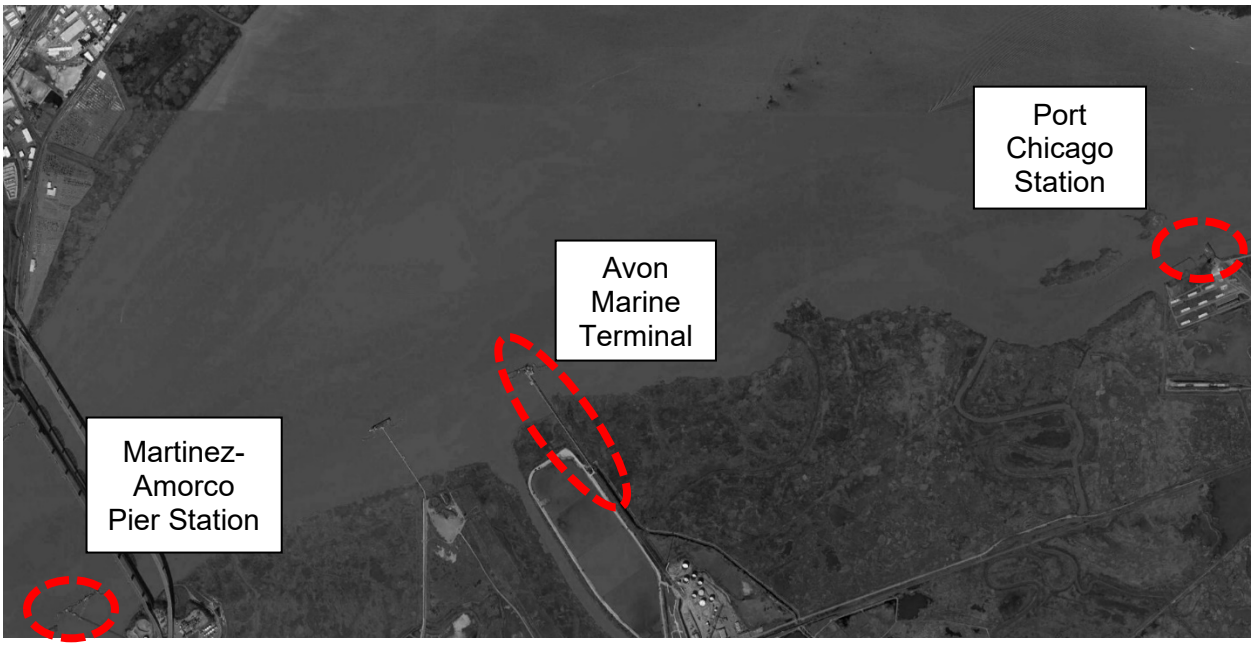

Figure 1 – Location of Marathon Avon Marine Terminal with respect to nearby NOAA stations.

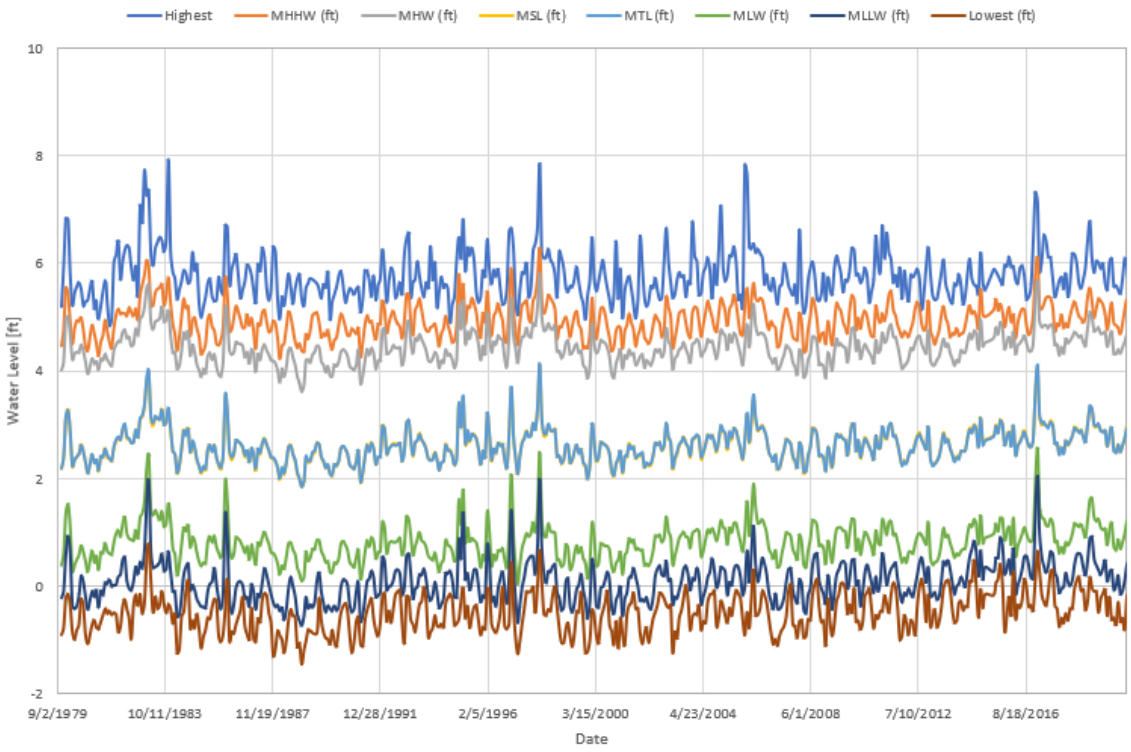

Figure 2 – Range of Port Chicago Station Monthly Historical Data

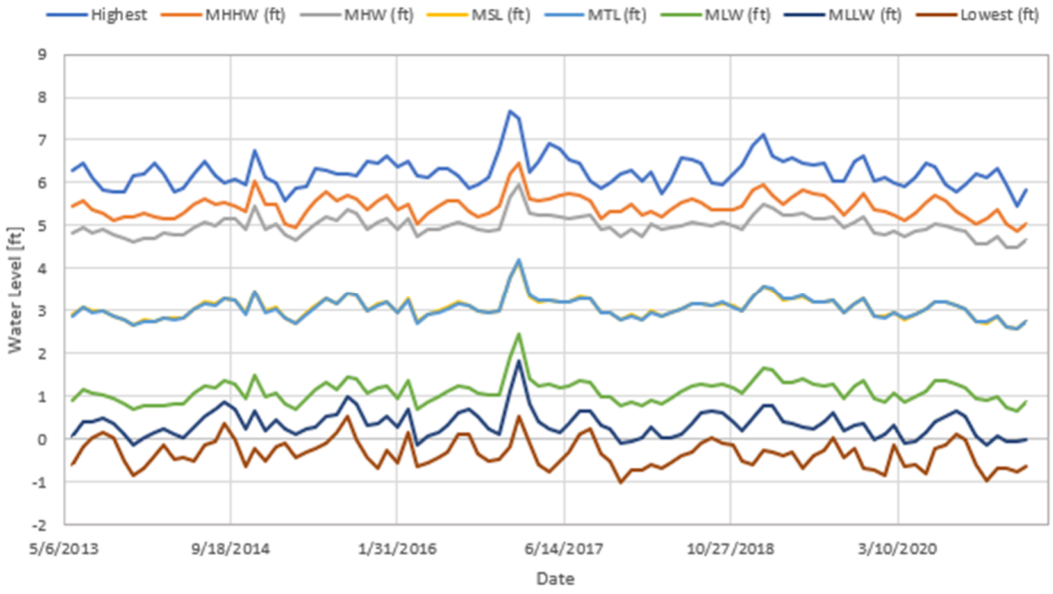

Figure 3 – Range of Martinez-Amorco Station Monthly Historical Data

AVON-SPECIFIC WATER LEVELS

We imported water level data from the two NOAA Tide and Metrological Observation Stations on either side of Avon in their local MLLW datum to create a water level dataset for Avon. The

available data has 95 recordings of months from 2013 to 2021, which allow a direct comparison to determine the tide relationships between the two stations. We converted the data to the North American Vertical Datum of 1988 (NAVD88) from the station-specific MLLW datum for our analysis. Once we set the NAVD88 water elevations for Avon, we converted back to MLLW to establish site-specific tide datums. Table 1 lists the available tide datums for the Amorco and Port Chicago stations with respect to MLLW.

Table 1 – Nearby NOAA Station MLLW Tide Datums

Abbreviation	Tide	Martinez-Amorco Pier EL. (ft)	Port Chicago EL. (ft)
-	Highest Observed Tide	7.68	7.92
MHHW	Mean Higher High Water	5.36	4.91
MHW	Mean High Water	4.84	4.40
MSL	Mean Sea Level	2.86	2.57
MLW	Mean Low Water	0.88	0.74
MLLW	Mean Lower Low Water	0.00	0.00
-	Lowest Observed Tide	-1.02	-1.47

Table 2 provides the Avon Tidal Datums as determined from the neighboring NOAA Stations. We used the average water level difference of the two sites and combined it with the readings from Port Chicago from 1979 to 2013. Then in 2013, when data from Amorco was available, we took the midpoint of the two water levels to create a complete Avon water level record from 1979 to 2021. Our procedure is as follows:

- Δ_{avg}: Average difference in water elevations between the Amorco and Port Chicago Stations from the 2012 to 2021 dataset
- From 1979 to 2013: Port of Chicago + Δ_{avg} / 2
- From 2013 to 2021: (Port of Chicago + Amorco) / 2

Figure 4 presents the annualized MSL from 1979 to 2021 for the Amorco and Port Chicago stations along with that computed for Avon. The data shows an average difference of 0.83 ft between the water levels at the two stations.

Table 2 – Computed Avon Tidal Datums

Abbreviation	Tide	MLLW EL. (ft)	NAVD88 EL. (ft)
-	Highest Observed Tide	7.80	6.97
MHHW	Mean Higher High Water	5.14	4.30
MHW	Mean High Water	4.62	3.79
MSL	Mean Sea Level	2.71	1.88
MLW	Mean Low Water	0.81	-0.03
MLLW	Mean Lower Low Water	0.00	-0.84
-	Lowest Observed Tide	-1.25	-2.08

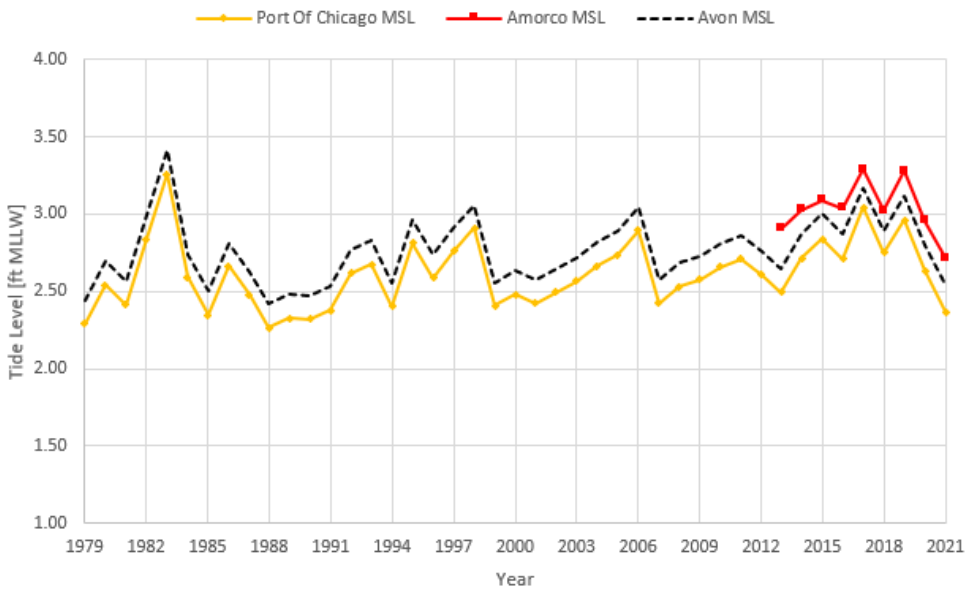

Figure 4 – Amorco, Avon, and Port Chicago Annualized MSL Comparison

FUTURE MSL FORECASTING

We used the MSL data as the basis to predict future water levels at the Avon terminal. MSL was selected as this data is less influenced by daily and seasonal highs and lows as it is a computation of the mean of recorded data. The MSL readings also incorporate sea level rise (SLR) trends for the local area. SLR predictions are also generally based on coastal locations. As the Avon site is more than 30 nautical miles upstream from the Golden Gate, addition of SLR predictions without modification would be excessively conservative.

To develop future water level predictions, we developed future water level trendlines based on 10-yr, 20-yr, and 40-yr look back periods. The intent of using various durations was to understand and capture various water level changes based on long and short-term perspectives. Figure 5 demonstrates the 1979-2021 MSL dataset with 10-yr, 20-yr, and 40-yr lookback projections of future water level changes into 2051. Using these trendline projections, we estimated the MSL changes into the future to predict 2-yr, 4-yr, 10-yr, and 30-yr water levels. The projected water level changes, based on the different lookback trends, are tabulated in Table 3.

The developed trend lines vary for the lookback durations considered. The 10-yr and 30-yr trends predict less water level increases than the 20-yr trend, with the 10-yr predicting the least amount of rise. The 10-yr data set is likely heavily influenced by the recent years of drought in California, where water levels have been below "normal" volumes. However, for this assessment and to be conservative, we selected the 20-yr lookback with the highest prediction of water level rise to develop estimate MSL rise for this assessment. For the 2030 water level prediction, we estimate a 2.7 in. (0.221 ft) water rise to be added to either the extreme tide or 100-yr flood condition.

Table 3 – Future Avon MSL Projections based on Various Lookback Trends

Year Projection	10-yr Lookback (ft) / (in.)	20-yr Lookback (ft) / (in.)	40-yr Lookback (ft) / (in.)
2-yr	0.003 / <0.1	0.015 / 0.2	0.010 / 0.1
4-yr	0.007 / 0.1	0.030 / 0.4	0.019 / 0.2
10-yr	0.017 / 0.2	0.076 / 0.9	0.048 / 0.6
30-yr	0.052 / 0.6	0.221 / 2.7	0.144 / 1.7

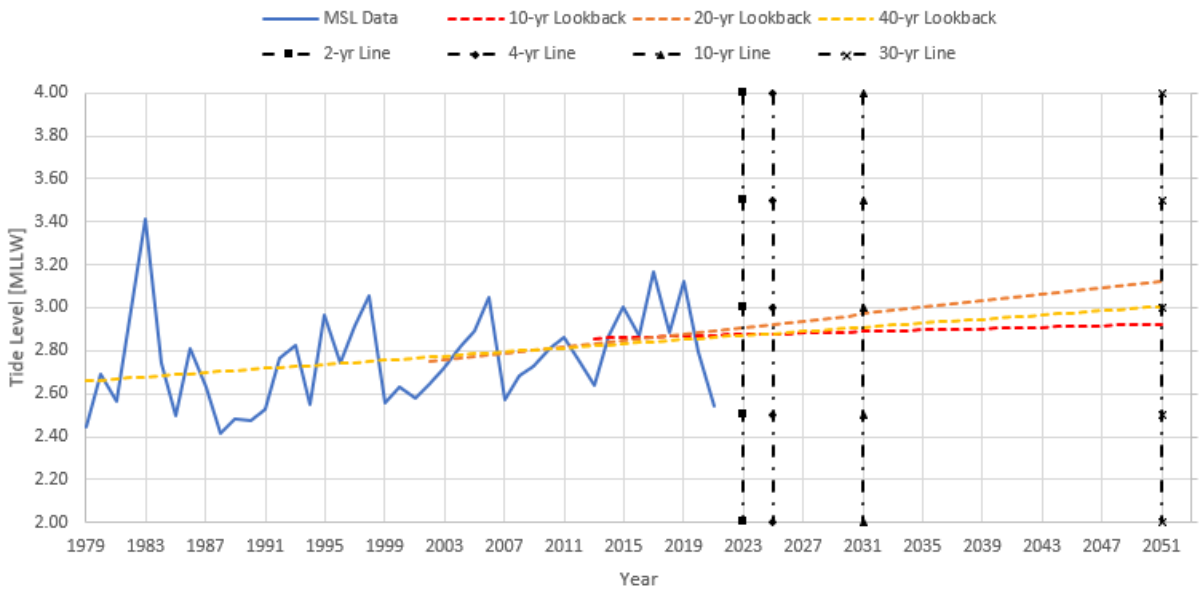

Figure 5 – Avon MSL Projections based on 10-yr, 20-yr, and 40-yr Lookback Trends.

100-YR FLOOD

The 100-yr flood elevation for the Avon terminal is estimated to be +8.2 ft MLLW, based on a 2014 site-specific study conducted by Marathon (formerly Tesoro) that was reported to BCDC and accepted as part of the permit application. This water level is inclusive of any extreme tide levels.

EXTREME TIDE

As required by the BCDC permit, we have estimated the extreme tide based on a 4-yr lookback. Extreme tides have been recorded in the data as the highest observed water level each month. The highest observed water level is not an average, but the actual measured level. This data is inclusive of water levels associated with storms and springtime runoffs. Over the previous four years, the data shows a maximum highest observed water level of +6.94 ft MLLW occurred in February 2019 (See Figure 6).

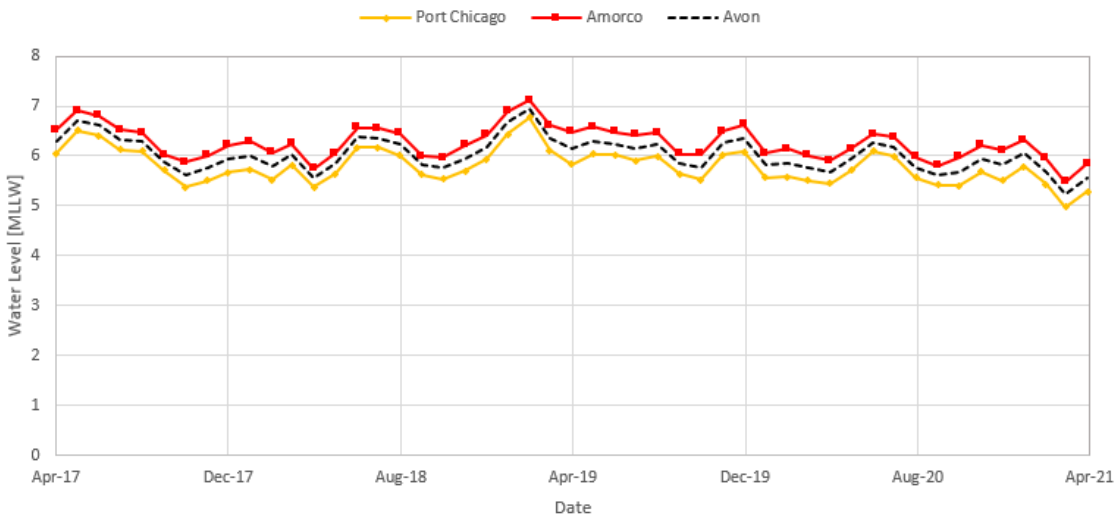

Figure 6 – Highest Observed Water Levels from April 2017 to April 2021.

VULNERABILITY ASSESSMENT

To assess the vulnerability of the Avon Trestle to flood inundation in 2030, we compared the elevation of the lowest cross beam with the predicted future water elevation for two flood scenarios. The two flood scenarios considered are:

1. 4-yr Extreme Tide considering water level rise based on the 20-yr lookback trend

2. 100-yr Flood considering water level rise based on the 20-yr lookback trend

Table 4 details the results of our assessment where the future water level is estimated based on the flood event and the 20-yr lookback trend. For both scenarios considered, the lowest level of the trestle is not likely going to be inundated by standing water.

Table 4 – 2030 Pipeway Vulnerability Scenarios

Scenario	Future Water Elevation (ft MLLW)	Lowest Trestle Elevation (ft MLLW)	Does Inundation Occur?	Available Freeboard (in.)
Extreme Tide + 2030 20-yr Lookback Trend	+7.02	+8.58	**No**	18.7
Flood Level + 2030 20-yr Lookback Trend	+8.42	+8.58	**No**	1.92

SGH would also like to point out the risk of oil spill associated with cross beam or pipeline inundation is very low. Both the structure and the pipelines can be exposed to flood inundation without significant risk of damage.

CONCLUSIONS

Based on this study, SGH concludes the following:

- Based on a 20-yr lookback trend, we predict the 2030 water level rise at the Avon terminal to be about 2.7 in.
- The risk of pipeline inundation at the lowest elevation of +8.58 ft MLLW before the next MOTEMS Audit in 2025 is very low.
- Based on the lookback trends for various time periods, the pipelines will not likely be inundated until 2070 assuming the measured rate of water level rise of 0.1 in./yr.
- Water levels should be monitored and reevaluated at the next MOTEMS Audit. At that time, we suggest the 100-yr flood elevation should also be reexamined.

CLOSURE

We respectfully suggest that Marathon submit this letter to BCDC for their review and approval.

If you have any questions or concerns regarding the contents of this letter, please feel free to contact either of the undersigned directly by phone or e-mail (wmbruin@sgh.com and mlargo@sgh.com).

Sincerely yours,

05/28/2021

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