



# City of Malibu

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April 8, 2019

Alison Kearns  
Chief, Risk Analysis Branch  
FEMA Region IX  
1111 Broadway, Suite 1200  
Oakland, CA 94607-4052

SUBJECT: Appeal of the Federal Emergency Management Agency (FEMA) Preliminary Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS)  
FEMA Comment Response

Dear Ms. Kearns:

Please see the attached comments to FEMA's November 8, 2018 response to the City's appeal of Preliminary Flood Insurance Rate Map and Flood Insurance Study.

The City is looking forward to working with FEMA to resolve these significant issues that provides the most accurate flood hazard information available to the City of Malibu.

If you have any questions, please call me at (310) 456-2489, extension 339.

Sincerely,

Rob DuBoux, PE, Esq.  
Public Works Director

Enclosures:

- Attachment A – FEMA comments provided on Nov. 8, 2018
- Attachment B – Responses to FEMA comments
- Appendix A – Transects 23 and 28
- Appendix B – New TWL calculations
- Appendix C – Detailed TWL results
- Appendix D – Detailed Results of TWL Statistical Analysis
- Appendix E – Detailed OT Results



cc: Reva Feldman, City Manager  
Ed Curtis, FEMA Region IX, Risk Analysis Branch  
Weixia Jin, Moffatt & Nichol



**Attachment A: Summary of City of Malibu Comments and FEMA Responses**

Comment # (L=Letter) (R=Report*)	Transect #	Comment / Response
<p align="center"><b>1</b></p> <p><b>(L1)</b></p> <p><b>(R1)</b></p>	<p>10, 11, 26, 27, 28, 29, 32, 33, 39, 40, 41</p>	<p>The general transect layout is acceptable. However, it is recommended to add one transect between each of the following: Transects 10 and 11, 26 and 27, 27 and 28, 28 and 29, 32 and 33, 39 and 40, as well as 40 and 41. Also, if the difference in BFEs between neighboring transects is more than 10 feet, a transitional zone shall be provided as stated in the Pacific Guidelines (Section D.4.9.6). "Transition zones may be necessary between areas with high run-up elevations to avoid large differences in BFEs and smooth the changes in flood boundaries."</p> <p>Significant Base Flood Elevation (BFE) differences can occur between mapping reaches where coastal BFEs are dominated by wave runup. Wave runup is very dependent on shore type and cross-shore profile characteristics, particularly runup slope. For example, a reach with a mildly sloping sandy beach adjacent to a reach with no beach and a steep vertical bluff can lead to a much lower BFE at the beach compared with the bluff. The FEMA Pacific Coast Guidelines (Reference 1) allow for the creation of transition zones between areas with high runup elevations to avoid large differences in BFEs and to smooth the change in flood boundaries. However, in the case of Los Angeles County, the rapid shore-type changes support rapid BFE differences, so the criterion for transition zones does not apply.</p> <p>Transect 10, for example, is partially sheltered from wave exposure as compared to Transect 11, resulting in a 7-foot difference in BFEs. The reaches are bounded appropriately according to shore types. A transition zone is not needed since the features of each reach are rather discrete. Similarly, Transects 26 through 29 exhibit marked differences in shore type, slope, and exposure. Transect 26 is partially sheltered and Transect 28 is based upon runup on a very steep slope with a deep toe, at about 5.1 feet NAVD88, which allows larger waves to break on the face of the bluff, resulting in significantly higher runup values. In this area, the reaches appear to be appropriately bound to the representative transects, and transition zones are not needed. Additionally, due to the steepness of the bluff, the horizontal difference at the transition from Transect 28 to Transect 29 is approximately 50 feet. None of the homes in this reach would be removed from an adjusted SFHA. Transects 32 and 33 have only a 6-foot difference in BFE and both transects represent their assigned reaches well. Transects 39 and 40 differ by 9 feet in BFEs, with the differences attributable to the marked difference in slope between the two reaches. The toe becomes deeper at Transect 41, further increasing the runup. Outside of those areas discussed, the only other area where the BFE difference exceeds 10 feet is between Transects 22 and 23. Transect 23 has a steep bluff face and a deep toe, resulting in a BFE of 23, which is 11 feet higher than at Transect 22. The reaches are well represented by the transect placements.</p>
<p align="center"><b>2</b></p>	<p align="center">General</p>	<p>The Base Flood Elevation (BFE) is very sensitive to topography, especially to bluff/structure toe elevation. Toe elevation determines which of three wave run-up methods (Stockdon, DIM or TAW) shall be used. When the</p>

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<p><b>(L2)</b> <b>(R2, R2a)</b></p>		<p>DWL2% (dynamic water level 2%) is below the toe of bluff/structure: 1) the Stockdon method is used if the foreshore slope is mild, and 2) the DIM method is used if the foreshore slope is steep. Physically, a steeper slope will result in a higher wave run-up than that in a milder slope. However, the Stockdon method for milder slopes results in higher wave run-up than that of the DIM method for steeper slopes. Hence, there is a clear sign that the Stockdon method is more conservative than DIM method for a similar shore type. When the DIM method is used, the BFE is often a few feet up to 10 feet lower than the neighboring transects.</p> <p>Different methods contributed to the alongshore BFE variations. Also, different methods were used for neighboring transects although they have similar shore/structure type. The City is currently conducting further review and analysis of several transects. Supporting and clarifying data will be submitted to FEMA within 30 days. Report addendum: The additional analysis provided in Section 2.2 indicates the differences between Stockdon and DIM Methods are much greater than described in the Study Contractor memo dated December 5, 2012. The large differences call into question the validity of these runup methods when applied to the Malibu coast.</p> <p>Report 2. a: The use of different runup methods contributed to the significant alongshore BFE variations. Also, different runup methods were used for neighboring transects although they have similar shore/structure type. A more consistent application of runup methods would result in less variation in BFE.</p> <p>Please refer to Section 4.3.2 in the IDS 3 Report (Reference 3) which describes the applied methodology in more detail. Due to the steep backshore topography of bluff-backed shorelines, the Stockdon and DIM methodologies cannot be applied for the calculation of wave runup during times when the dynamic water level, DWL2%, exceeds the bluff toe elevation and waves directly impact the steep face of the bluff. The FEMA Pacific Coast Guidelines recommends the use of the TAW method for computation of wave runup on steep profiles (<math>m &gt; 0.125</math> or steeper than 8:1 H:V). A hybrid method was adopted for application to bluff-backed shorelines within the Los Angeles County study area (described in more detail in the IDS 3 Report). The basic approach is to use either the Stockdon or DIM method (depending on foreshore slope steepness) to compute wave runup on the fronting beach for times when the bluff toe is not inundated, and the application of TAW is not reliable. Stockdon was often applied for beaches which had a steeper foreshore feature to appropriately capture the wave dynamics; DIM was typically used for reaches in which a more consistent onshore slope was appropriate. These assessments were made by the study team based upon a variety of factors as described in the IDS 3 Report.</p>

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		<p>The City of Malibu did not submit alternate or additional analysis and mapping in support of this comment during the 90-day appeal period. The City may submit alternate or additional analysis and mapping for consideration for revised mapping in the future using FEMA’s Letter of Map Revision process.</p>
<p align="center"><b>3</b>  <b>(L3)</b> <b>(R3, 3a, 3b)</b></p>	<p align="center">General</p>	<p>Wave analysis transects begin at a depth of 40-m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave run-up analysis is a poor choice for reaches with oblique wave approach angles and wave refraction patterns, which occur around the many headlands. Some of the two-dimensional (2-D) wave phenomena captured in a 2-D refraction model is not adequately represented in the one-dimensional transect based analysis, potentially leading to overestimates of the BFE. However, this may not be an issue if the depth-limited wave height is used in the wave run-up analyses. Report addendum: A detailed review of shelf model results including nearshore wave height and refraction patterns should be performed by FEMA to demonstrate that using wave parameters from the SHELF model at the 40-meter depth for 1D transect based analysis does not over-estimate wave conditions nearshore. Limited wave runup analysis indicates that the BFE may be reduced by 10% if oblique wave approach impact is properly considered. Additional potential issues related to wave input data are listed below:</p> <p><b>Report 3. a:</b> The record event jumps around between consecutive neighboring transects, as shown in Table 5-1. Transects 35, 37 and 39 have the same record event and time step, but Transect 36 in between has a different record event, and Transect 38 has a different time step, which is strange and does not make sense.</p> <p><b>Report 3. b:</b> Wave periods between neighboring transects were often different for the same storm event and time step, which does not make sense. Wave period is a key input parameter in wave runup calculations, and a wrong period could lead to a wrong TWL and BFE. Below are some examples: Wave periods were different for the same storm event and time step between following pairs of consecutive neighboring transects: Transects 11 and 12, Transects 23 and 24, Transects 27 and 28, and Transects 41 and 42 Table 5-2 illustrates wave period variations between consecutive neighboring transects during 1/27/1983 storm event. The time steps were within 3 hours, but three different periods were used, which does not make sense. Similarly, Table 5-3 illustrates wave period variations for 3/1/1983 storm. Three different periods were used from Transect 22 through 28 for the same time step, and again three different periods were used on three consecutive transects for the same time step.</p> <p><b>Report 3. c:</b> Note, there are two transects in the table below where the wave heights used in the analysis are much lower than adjacent transects. <b>Based on our review of the profile data it appears that Transects 19 and 25 used wave parameters from the depth contours of 25 and 15 meters, respectively.</b> These wave heights are 50% lower than wave heights used at the other transects (assumed to be from the 40-meter depth contour)</p>

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		<p>and illustrate how much wave heights could be overestimated by applying wave parameters that don't account for the dissipating and sheltering effects of nearshore points, reefs and headlands.</p> <p>Waves considered in the analysis are spectrum waves rather than monotonic waves. Nearshore wave modeling was performed to transform deepwater wave conditions at the edge of the surf zone, at 5, 10, and 15m water depths, using the spectral refraction model, <b>SHELF</b>. The output from the nearshore wave transformation model provided the input conditions for the 1-D transect-based wave hazard analyses, including wave runup calculations. Different dynamics occur during each event at different locations, so it is not uncommon or unusual to have different time steps or events correlate with the highest wave heights or Total Water Levels (TWLs). Different wave heights and periods are also common between different locations due to underlying influences including sheltering, bathymetric features, etc. A comparison of the wave spectra of neighboring transects that experience similar wave exposure shows that they are similar in shape and the mean periods show consistent values across similar transects. Similarly, as the waves approach shallow water, there is a there is a shift in <b>wave energy from lower frequencies to higher frequencies, resulting in smaller wave periods nearshore, but the mean periods and overall shape of the wave spectra is similar.</b> Detailed information regarding the offshore wave modeling can be found in the <b>IDS 2 Report (Reference 2)</b>.</p>
<p align="center"><b>4</b>  <b>(L4)</b></p>	<p align="center">General</p>	<p>The foreshore slope is not considered in determining the wave breaking criterion (ratio of wave height to water depth). A wave breaking factor of 0.78 for the flat beach was used for all transects, which may lead to an underestimate of the depth-limited breaking wave height and resulting BFE.</p> <p>Waves considered in the FEMA analysis are random waves. The method suggested in the comment letter applies the following expression for the breaker depth index noted in the Coastal Engineering Manual (Reference 5):</p> $\gamma_b = b - a \frac{H_b}{g T^2}; a = 43.8(1 - e^{-19 \tan \beta}); b = \frac{1.56}{(1 + e^{-19.5 \tan \beta})}$ <p>which was derived for regular waves from laboratory data on monochromatic waves breaking on smooth, plane slopes. The monochromatic breaking criteria is overly conservative for random waves. To address this, the study applied a different formula in order to have a better estimation of breaking wave height (<i>equation 4.3-20 as shown in the IDS 3 Report</i>).</p>
<p align="center"><b>5</b>  <b>(L5)</b> <b>(R5, 5a)</b></p>	<p align="center">General, 31, 32, 34, 35, 37, and 39</p>	<p>Treatment of shore protection structures has a significant impact on BFEs. The revetment was assumed to be intact for Transects 11 and 42. Shore protection structures at other transects were assumed to be removed (failed) in the analyses. For failed condition analyses, rubble/riprap were completely removed from the transect geometry and the roughness factor was replaced with that of sand (i.e., very smooth). The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: "the Mapping Partner shall</p>



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		<p>select an appropriate roughness factor when conducting run-up and overtopping analyses on the failed structure." Report addendum: The additional analysis provided in Section 4 indicate a use of an intermediate roughness value for rocky bluffs or "partially failed" structures could result in a significant reduction in calculated TWL and BFE.</p> <p>There are several reaches in Malibu where coastal structures line the back beach but were not included in the analysis. These reaches are represented by Transects 31, 32, 34, 35, 37 and 39. As the cover photo indicates, runoff at the structures can reach high elevations, yet there is very little flooding landward of the structures. This is a case where the runoff method should have accounted for these structures and their effect on primary and secondary hazard zones.</p> <p>For certain transects, a partial failure scenario was evaluated to test the full range of possible structure configurations. These include revetments at dunes. Partial failure configurations were also considered for revetments at bluffs, but only applied at revetments where there is verified, documented evidence that a partial failure analysis is warranted over a removed analysis. This evidence might include accreditation by FEMA or the USACE, assessment of historical performance, or detailed structural evaluation. Furthermore, the partial failure scenario was only considered at transects where the partial failure geometry is physically reasonable and fits within the physical constraints of the profile. For removed analyses, roughness reduction factors were selected to best match the underlying natural profile material (e.g., sandy or rocky) (<i>IDS 3 Report</i>). The treatment for each reach that contains structures and the roughness coefficients selected follows the approach prescribed in the Pacific Coast Guidelines and is documented in the IDS 3 Report. Note that the analysis at Transect 39 was re-evaluated per Comment #11 in this document because the feature points were incorrectly identified.</p>
<p align="center"><b>6</b></p> <p align="center"><b>(L6a)</b> <b>(R6a)</b></p>	<p align="center">11</p>	<p>The secondary VE elevation in Table 1 of IDS4 is 1 foot higher than the primary VE elevation.</p> <p>For Transect 11, the VE Zone BFE behind the crest of the feature should be 18.4 feet using the Cox-Machemel method. Note that this BFE does not inform the mapping at this location.</p>
<p align="center"><b>7</b></p>	<p align="center">20</p>	<p>For Transect 20, the BFE is 19 feet, while the total water level (TWL) of the event of the record is only 11.7 feet according to the supporting FIS documents.</p>

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<b>(L6b)</b> <b>(R6b)</b>		For Transect 20, an 11.7 feet total water level has been confirmed and the associated mapping on Preliminary Flood Insurance Rate Map (FIRM) panels 06037C1518G and 06037C1519G has been changed to reflect a BFE of 12 feet.
<b>8</b> <b>(L7)</b> <b>(R7)</b>	General	<p>A 35-foot minimum distance criterion was applied in mapping a secondary VE or AO zone for transects with overtopping. If the resulting landward overtopping distance was less than 35 feet, the overtopping run-up zones were integrated into the primary wave run-up Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary overtopping zone VE with a different (often lower) BFE. At 13 transects there was overtopping calculated, but the distance was less than 35 feet; therefore, the primary run-up zone BFE was extended to cover this area. Since the primary run-up zone BFE is often a few feet higher than the calculated overtopping zone BFE, the resulting mapped BFE is higher than the calculated BFE at these transects. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the City of Malibu was not consulted about setting 35-foot as the minimum mappable distance criterion.</p> <p>A minimum mapping distance criterion of up to 38 feet is regularly applied due to limitations in map scale on FIRMs. However, communities can consult the more detailed breakdown of the overtopping hazard information listed in the IDS 4 Report (Reference 4) to administer their flood hazard ordinances in these overtopped areas.</p>
<b>9</b> <b>(L, closing)</b>		<p>As stated, the City's consultant will be performing additional review and analysis of 22 transects (8, 9, 11, 20, 23-25, 27, 28, 31-43). This additional analysis will also include evaluating FEMA's topographic data located where houses are elevated on pile structures. Since FEMA utilized LIDAR data to obtain the topographic data, this method would not cover the area under the house and the assumptions made by FEMA may not represent actual site conditions. This additional review and analysis will be used to provide supporting data and documentation as part of this appeal.</p> <p>Alternate analysis and mapping must be provided to FEMA within the 90-day appeal period to be considered for revised mapping. Neither the original comment letter received on November 6, 2017, nor the February 2018 report compiled by Moffat &amp; Nichol contain revised analysis and mapping, and therefore will not be incorporated into the revision.</p>

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<p align="center"><b>10</b></p> <p align="center"><b>(L3d)</b></p> <p align="center"><b>(R3d)</b></p>	<p align="center">30-37</p>	<p>At Transects 30 to 37 there is an extreme event with a very long wave period (&gt;25 seconds) that is outside of the typical range seen here on the west coast. Wave periods longer than 22 seconds are typically associated with forerunners from southern hemisphere swell events with small wave heights often less than 2 feet. The April 25, 1998 wave event listed in the IDS TWL has a wave height of 5 feet associated with the very long wave period. A closer review of measured data at nearby wave buoys indicates no sign of such an event. As the CDIP nearshore wave plot (below) shows, the wave periods reported on this day are much shorter than used in the analysis. Since this event ranks among the highest calculated TWL events at several transects, it does have an influence over the BFE in several locations. We recommend additional investigation by the Study Contractor to determine if this is a valid wave event to be included in the TWL and BFE analysis. If this wave event is not represented by actual buoy measurements and is an artifact of the hindcast methods, it should be discarded from the analysis.</p> <p>Statistics for Transects 30-37 were recalculated after removing the April 25, 1998 event. While this led to a reduction in BFEs for each transect, the results were consistently less than 0.3 feet and result in no changes to the BFEs along these transects which are rounded off to the nearest whole foot.</p>
<p align="center"><b>11</b></p> <p align="center"><b>(R6c)</b></p>	<p align="center">39</p>	<p>Transect 39: shoreline features (crest and toe) are incorrectly determined. If transect crest and toe were defined in a manner consistent with adjacent transects, a different runup method (probably TAW) would have been applied, resulting in a BFE similar to adjacent transects.</p> <p>FEMA agrees that the toe and crest locations were incorrectly determined for this transect. The toe and crest locations were re-selected for this profile, and the new BFE was recalculated as 21.7 feet, resulting in a whole foot BFE of 22 feet. This result is more consistent with the adjacent BFEs of 20 feet at Transect 38 and 21 feet at Transect 40. The associated mapping on Preliminary FIRM panel 06037C1542G has been changed to reflect a BFE of 22 feet.</p>
<p align="center"><b>12</b></p> <p align="center"><b>(R6d)</b></p>	<p align="center">42</p>	<p>Transect 42: The secondary VE BFE is higher than the primary VE BFE.</p>

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		<p>The Transect 42 study reach is mapped with a whole foot BFE of 22 feet (identified as the primary BFE in the comment) which is based on analysis of wave runup on an intact revetment at the transect location resulting in a TWL of 21.5 feet. The calculated TWL for the unprotected bluff condition which is prevalent over much of the Transect 42 study reach is 28.4 feet. The study team determined that the unprotected bluff overtops with a TWL of 25.7 feet (identified as the secondary BFE in the comment). Comparing the runup and overtopping TWLs for the unprotected bluff condition, the overtopping TWL is 3.7 feet lower than the runup TWL which is consistent with the water surface elevation results at other overtopped bluff transects. The overtopped area extends 31.1 feet beyond the crest of the bluff.</p> <p>The study team based the mapping for the Transect 42 study reach on the intact structure TWL of 21.5 feet with a horizontal extension of 31.1 beyond the bluff crest to account for overtopping.</p>
<p align="center"><b>13</b>  <b>(R4)</b></p>		<p>Wave runup is very sensitive to the beach slope. Sandy beaches are highly dynamic and beach slopes can vary over time. The beach slope is based on a single data set, and long-term beach profile data can help to identify a range of slopes to determine the most appropriate slope value to apply in runup calculations. Another issue with a single transect is the representation of the slope for the reach being represented.</p> <p>The study team chose slopes that were representative of the conditions generally found along that study reach. The City of Malibu did not submit alternate or additional analysis in support of this comment during the 90-day appeal period. The City may submit alternate or additional analysis and mapping for consideration for revised mapping. in the future using FEMA’s Letter of Map Revision process.</p>
<p align="center"><b>14</b>  <b>(R, Section 3)</b></p>	<p align="center">General</p>	<p>The effect of oblique wave approach cannot be included in Stockdon and DIM Methods but should have been captured in the two-dimensional (2D) SHELF model performed for the FEMA study. Therefore, it would be more accurate if wave parameters used in wave runup analyses were extracted from the SHELF model at a shallower depth, such as 10 meters or even 5 meters instead of 40 meters. The wave approach angle varies from transect to transect and are more than 45 degrees for the seven selected transects for analyses; hence, a 45-degree approach angle, which would result in a reduction factor of 0.8, was used in the limited analysis.</p> <p>Nearshore wave modeling was performed to transform deepwater wave conditions at the edge of the surf zone, at 5, 10, and 15m water depths, using the spectral refraction model SHELF. The output from the nearshore wave transformation model provided the input conditions for the 1-D transect-based wave hazard analyses, including wave runup calculations.</p> <p>Waves approaching the shoreline at each transect that were greater than 45 degrees from that transect were excluded from the analysis.</p>

\*Unless otherwise noted, all Report comment numbers correspond to Section 4. Technical Comments.

## Attachment A: Summary of City of Malibu Comments and FEMA Responses

### References:

- 1) "Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping of the Pacific Coast of the United States," FEMA, January 2005
- 2) "Intermediate Data Submittal #2, Offshore Waves and Water Levels, Southern California," BakerAECOM, January 6, 2015
- 3) "Intermediate Data Submittal #3, Nearshore Hydraulics, Los Angeles County, California," BakerAECOM, October 12, 2015
- 4) "Intermediate Data Submittal #4, Flood Hazard Mapping, Los Angeles County, California," BakerAECOM, March 10, 2016
- 5) *Coastal Engineering Manual* (EM 1110-2-1100), U.S. Army Corps of Engineers, August 1, 2008

## Attachment B - Responses to FEMA Comments Dated on November 8, 2018

### Comment # 1 (L1) (R1)

City Response: An additional transect between Transects 10 and 11 is warranted. The BFE at west segment of the reach represented by Transect #11 is likely overestimated as a result of ignoring the oblique wave impact.

An additional transect between Transects 26 and 27 is warranted. Transect 27 does not reflect conditions at seven properties near the intersection of Corral Canyon Rd and E Pacific Coastal Hwy. The BFE is likely overestimated because of ignoring the oblique wave impact.

An additional transect between Transects 32 and 33 is warranted. Transect 33 does not reflect conditions west of Malibu Pier, where the BFE is likely overestimated due to ignoring the oblique wave impact.

### Comment #2 (L2) (R2, R2a)

City Response: The alongshore BFE variability due to different runup methods applied should be addressed systematically by FEMA. This variability causes difficulty for the local communities in administering flood ordinances. Below are two examples of BFE variability caused by the runup methods:

- Comparing Transects #9 and #10, #9 has a higher toe elevation and a milder slope than those of neighboring Transect #10 listed in the table below, but a higher BFE than that of #10. Physically, wave runup on a milder slope should be lower than that of a steeper slope, hence, #9 should have a lower BFE than #10. If the DIM Method were used like that used in #10, the BFE of #9 would have been lowered by a few feet, being close to #10, and the results will be more realistic.
- Similarly, between Transects #26 and #27, the Stockdon Method was applied at #27 due to a milder slope, resulting in a much higher BFE. Again, this is against reality. If the DIM method were applied at #27, the BFE would have been lowered by a few feet, being close to #26.

Transect # Map (Study)	Toe (ft NAVD)	Foreshore slope	Face slope	Method	BFE (ft NAVD)
9 (1109)	11.8	0.11	0.59	Stockdon	20
10 (1104)	9.9	0.15	0.62	7 TAW, 117 DIM	14
26 (971)	14.8	0.12	0.632	DIM	13
27 (956)	12.8	0.11	0.308	Stockdon	20

### Comment #3 (L3) (R3, R3a, 3b)

City Response: Understanding wave energy shifts from lower frequencies to higher frequencies, resulting wave period changes when waves approach the shallower water, the alongshore variability indicate that denser transects are required to reduce the wave parameter, ultimately the BFE variability.

#### Comment #4 (L4)

City Response: Accept

#### Comment #5 (L5) (R5, 5a)

City Response: FEMA's treatment of removing shore protection structures without considering the roughness reduction for failure condition analyses are too conservative, as those shore protection rocks will still be present on the slope even if they failed, especially for the shore protection structures that survived the record storm event.

#### Comment #6 (L6) (R6a)

City Response: Request the IDS reports are updated with the new calculation as this correction is important for the City in administering flood hazard ordinances in these overtopped areas.

#### Comment #7 (L6b) (R6b)

City Response: Accept

#### Comment #8 (L7) (R7)

City Response: The City strongly insists the use of digital map. The BFE should be mapped with calculated potential flood elevations, not combining the adjacent zones using the 35-foot minimum mapping distance criterion.

#### Comment #9 (L, closing)

City Response: A new and more accurate topographic and bathymetry survey was performed for Transects #23 and #28. The certified survey results are included as in Appendix A.

- For Transect #23, the new survey results indicate a bluff toe elevation of 9.84 ft instead of 6.7 ft used in PFIRM and a bluff crest elevation of 23.1 ft instead of 22.2 ft used in PFIRM. With the new bluff crest and toe elevations, the resulting BFE is 15 ft. The detailed calculations including the transect profile plot, new total water level (TWL) calculations, and TWL statistical analyses are included in Appendix B.
- For Transect #28, the new survey results indicate a seawall toe elevation of 15.6 ft instead of 5.1 ft used in PFIRM and a bluff crest elevation of 23.1 ft instead of 23.3 ft used in PFIRM. With the new bluff crest and toe elevations, the resulting BFE is 15 ft, which is similar to the BFE of 16 feet at the neighboring Transect #29. The detailed calculations including the transect profile plot, new TWL calculations, and TWL statistical analyses are included in Appendix B.

#### Comment #10 (L3d, R3d)

City Response: Accept

#### Comment #11 (R6c)

City Response: Accept

#### Comment #12 (R6d)

City Response: Accept the decision of FEMA's study team on mapping Transect #42 (824) with the revetment intact condition, but request the oblique wave approach impact being considered in the

calculation. The new calculation with the oblique wave approach impact is discussed in response to Comment #14.

Note that the secondary BFE for the unprotected bluff condition is 24.7 feet according to Table 1 of IDS#4, not 25.7 feet in FEMA’s comment, likely a typo.

**Comment #13 (R4)**

**City Response:** Accept

**Comment #14 (R, Section 3)**

**City Response:** The TWLs were re-calculated by applying the reduction factor ( $\gamma_B$ ) due to oblique wave approaching at Transects #25/976, #38/859, and #42/824, where TAW method was applied. Being consistent with using wave parameters at the 15-m contour in the transect based analyses in the PFRIM, wave directions at the 15-m contour provided by FEMA on March 28, 2019 were used in computing the wave angle reduction factor. The steps of computing the revised 1% BFE at each transect are summarized below:

- Extract wave direction data from FEMA’s 50-year time series (data at the 15-m contour used for PFRIM analysis) for all peak events;
- Compute wave approaching angle and the corresponding reduction factor for all extreme events that the TAW method was used;
- Compute the revised wave runup utilizing the TAW method (Los Angeles County IDS#3, Eq. 4.3-19) for all extreme events that the TAW method was used;
- Compute the TWLs (Los Angeles County IDS#3, Eq. 4.3-28) for all extreme events that the TAW method was used;
- Conduct statistical analysis of TWLs following the approach in IDS#3 and estimate extreme TWLs using GPD/POT (Transects #25/976, #38/859 and #42/824) method; and
- Compute wave overtopping and define hazard zones.

The revised BFEs and SFHA boundaries are listed below by transects. The BFE reduction is a result of considering the oblique wave approach impacts for Transects #25, #38, and #42; and using new survey profile data for Transects #23 and #28.

<b>Transect (Map/Study)</b>	<b>FEMA PFIRM VE Zone BFE (ft NAVD)</b>	<b>Revised VE Zone BFE (ft NAVD)</b>	<b>Revised Secondary VE Zone BFE (ft NAVD)</b>	<b>*Secondary VE Zone Landward Extent (ft)</b>	<b>*AO Zone Landward Extent (ft)</b>	<b>AO Zone Width (AO Zone Extent - 2nd VE Extent) (ft)</b>
23/987**	23	15	-	-	-	-
25/976**	20	16	-	-	-	-
28/946**	31	15	-	-	-	-
38/859	20	19	18	1	21	20
42/824**	22	20	-	-	-	-

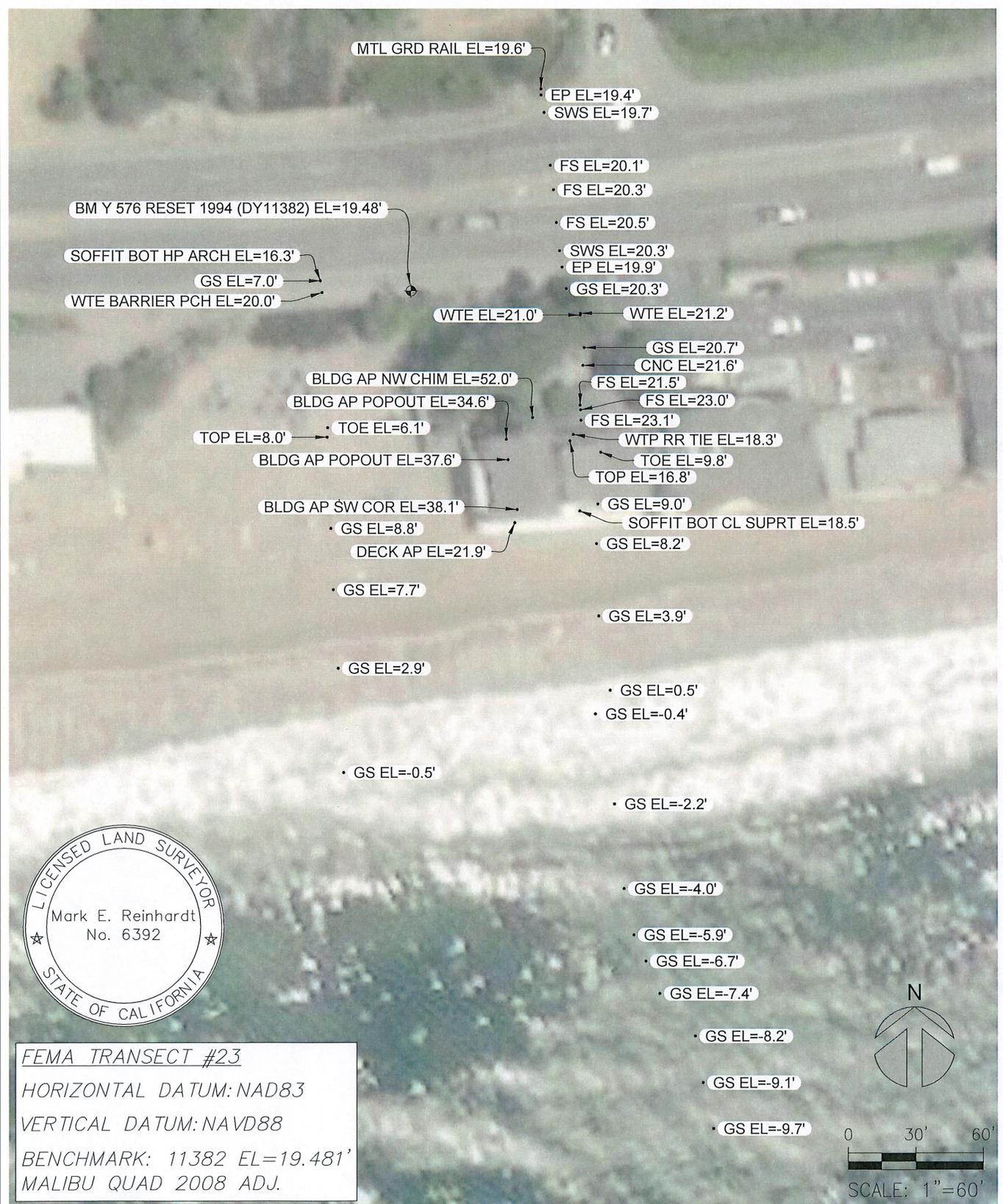
*\*Measured from transect crest.*

*\*\*BFE is lower than crest elevation. No overtopping at this transect.*

The following supporting documents are submitted together with this response:

- Detailed TWL results from calculations only considered the reduction from oblique wave angles (Appendix C);
- Detailed results of statistical analysis (Appendix D);
- Detailed overtopping results (Appendix E);

The wave parameter file provided on 3/28/2019 for Transect #41 (LA831) was truncated; hence, the impact of oblique wave approach to the BFE cannot be calculated at this time due to missing data. The new calculation will be submitted as an addendum to this response after receipt of the complete data file from FEMA.



FEMA TRANSECT #23  
 HORIZONTAL DATUM: NAD83  
 VERTICAL DATUM: NAVD88  
 BENCHMARK: 11382 EL=19.481'  
 MALIBU QUAD 2008 ADJ.



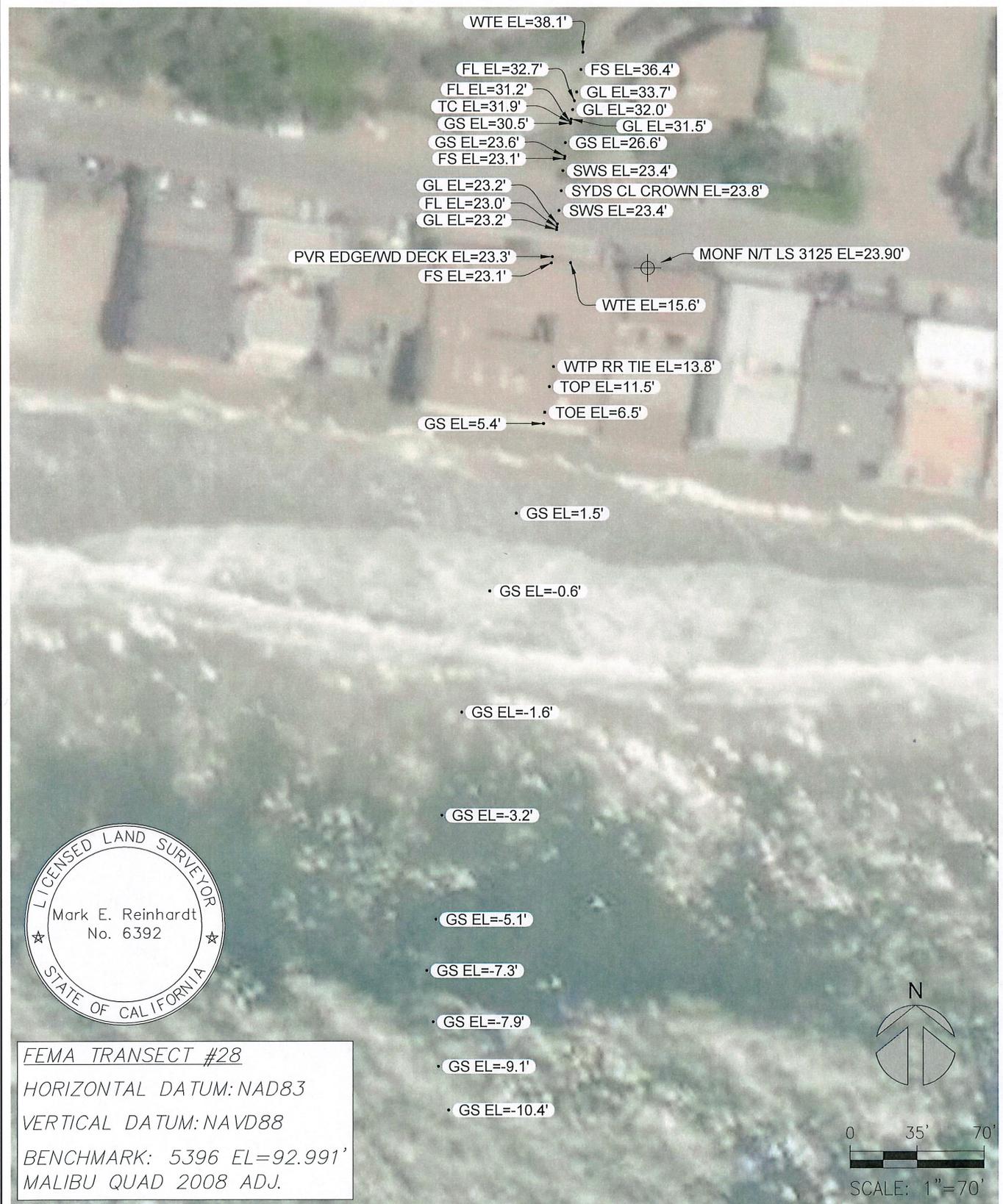
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ENGINEERING  
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 CONSTRUCTION MANAGEMENT

CIMAL.170264.00 TASK 31 \* FEMA Transects.dwg \* 04/05/2019 \* RCS \* E-FILE

THIS SURVEY WAS PERFORMED BY ME OR UNDER MY SUPERVISION ON MARCH 1, 2019.

SIGNATURE:   
 MARK E. REINHARDT, PLS 6392



FEMA TRANSECT #28  
 HORIZONTAL DATUM: NAD83  
 VERTICAL DATUM: NAVD88  
 BENCHMARK: 5396 EL=92.991'  
 MALIBU QUAD 2008 ADJ.

**MNS**  
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ENGINEERING  
 PLANNING  
 SURVEYING  
 CONSTRUCTION MANAGEMENT

THIS SURVEY WAS PERFORMED BY ME OR UNDER MY SUPERVISION ON MARCH 1, 2019.

SIGNATURE: *[Handwritten Signature]*  
 MARK E. REINHARDT, PLS 6392

**Summary Sheet: New TWL Calculations and Statistical Analysis with City Surveyed Profiles**

Prepared By: Q. Wang  
4/8/19

MN JN: 9937 City of Malibu FEMA Appeal

**Table 1. Transect Attribute Database for City Surveyed Transects #23(LA987) and #28(LA946), Los Angeles County**

Transect ID	Offshore Easting (m)	Offshore Northing (m)	Onshore Easting (m)	Onshore Northing (m)	Azimuth (Deg)	Backshore	Analysis Shoretype	Sediment Category	SHELF ID	NOAA Tide Station ID	Foreshore Beach Slope (m <sub>f</sub> )	Backshore Beach Slope (m <sub>b</sub> )	Face Slope (m <sub>face</sub> )	Backshore Feature Toe (E <sub>j</sub> ) (ft NAVD)	Backshore Feature Edge (E <sub>edge</sub> ) (ft NAVD)	Backshore Feature Crest (E <sub>crest</sub> ) (ft NAVD)	Backshore Feature Heel (E <sub>heel</sub> ) (ft NAVD)
23/LA 987	337367.10	3764146.02	336984.12	3766488.43	170.7	Bluff	5.0	Medium	LA987	9410840	0.127	-	0.88	9.84	23.1	23.1	-
28/LA 946	340432.82	3764433.66	340918.99	3767222.25	189.9	Bluff	5.0	Medium	LA946	9410840	0.140	-	0.101	15.6	23.1	23.1	-

**Table 2. Summary of TWLs Statistical Analysis Results and Reasonableness Assessment**

Transect	2% Annual Chance TWL (50-year) (ft NAVD)	1% Annual Chance TWL (100-year) (ft NAVD)	0.2% Annual Chance TWL (500-year) (ft NAVD)	Statistical Method Used	Highest 50-year TWL (ft NAVD)	Assessment of Reasonableness**		
						Criteria 2-1: Highest 50-year TWLs between 1% and 2% TWLs	Criteria 2-2: 1% TWLs within 1ft of Highest TWLs	Criteria 3: Difference between 0.2% and 1% TWLs less than 3ft
23/LA 987	14.5	14.9	16.1	GPD/POT	14.9	Yes	Yes	Yes
28/LA 946	14.2	14.6	15.7	GPD/POT	14.7	No	Yes	Yes

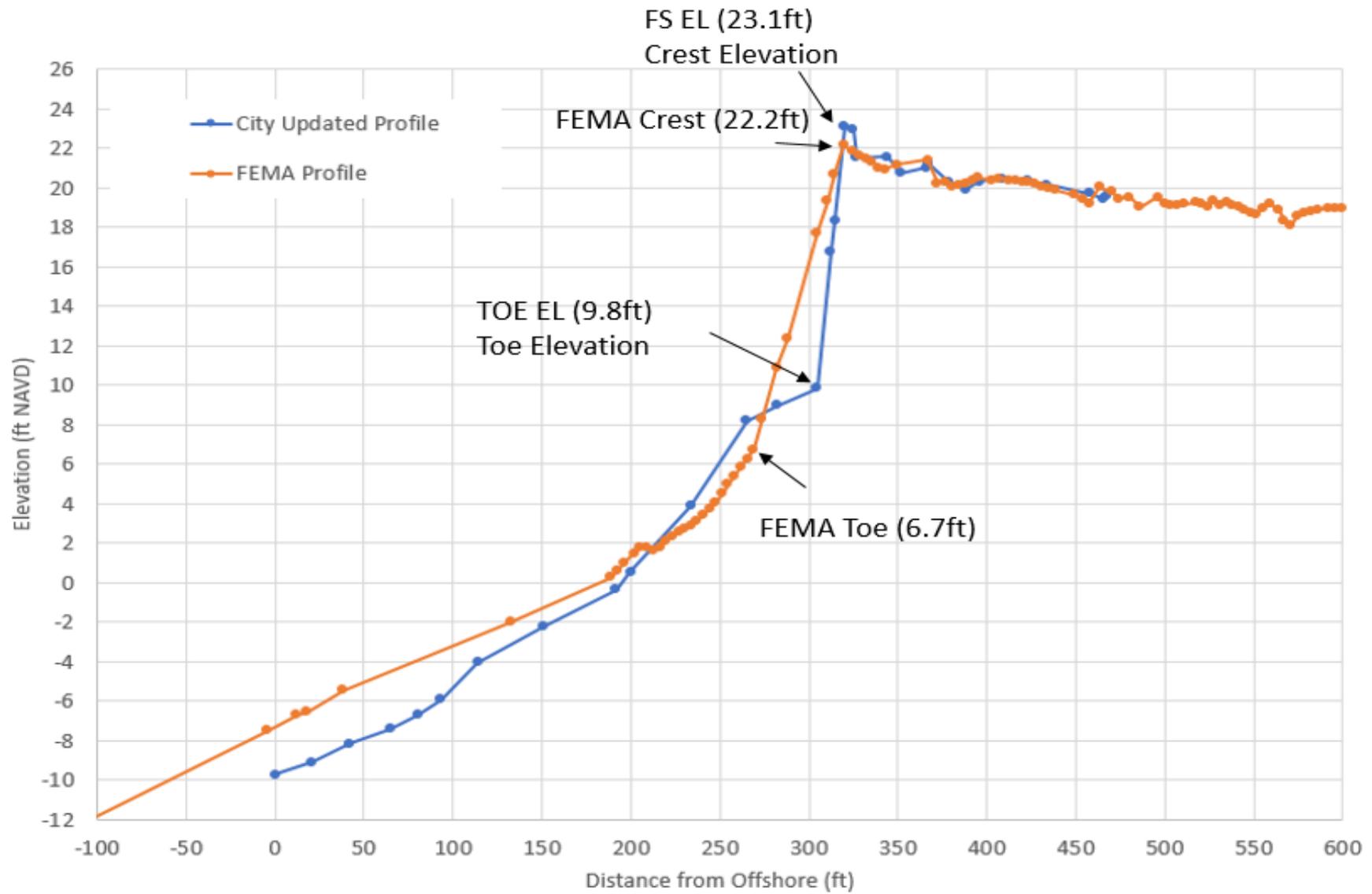
\* X% annual chance TWLs are estimated using upper limit values based on the fitting of the data.

\*\* No enough data to assess the reasonableness assessment criteria 1 - 1% TWLs from GEV/AM and GPD/POT less than 3ft. It is also mentioned in IDS#3 that "both methods generally provided reasonable and comparable estimates of extreme TWLs within the study area".

**Table 3. Summary of BFEs for City Surveyed Transects #23(LA987) and #28(LA946), Los Angeles County**

Transect	Backshore	Runup Method	FEMA PFIRM VE	Revised VE
			Zone BFE (ft NAVD)	Zone BFE (ft NAVD)
23/LA 987	Bluff	131 DIM/8 TAW	23	15
28/LA 946	Bluff	All DIM	31	15

# Transect #23/987

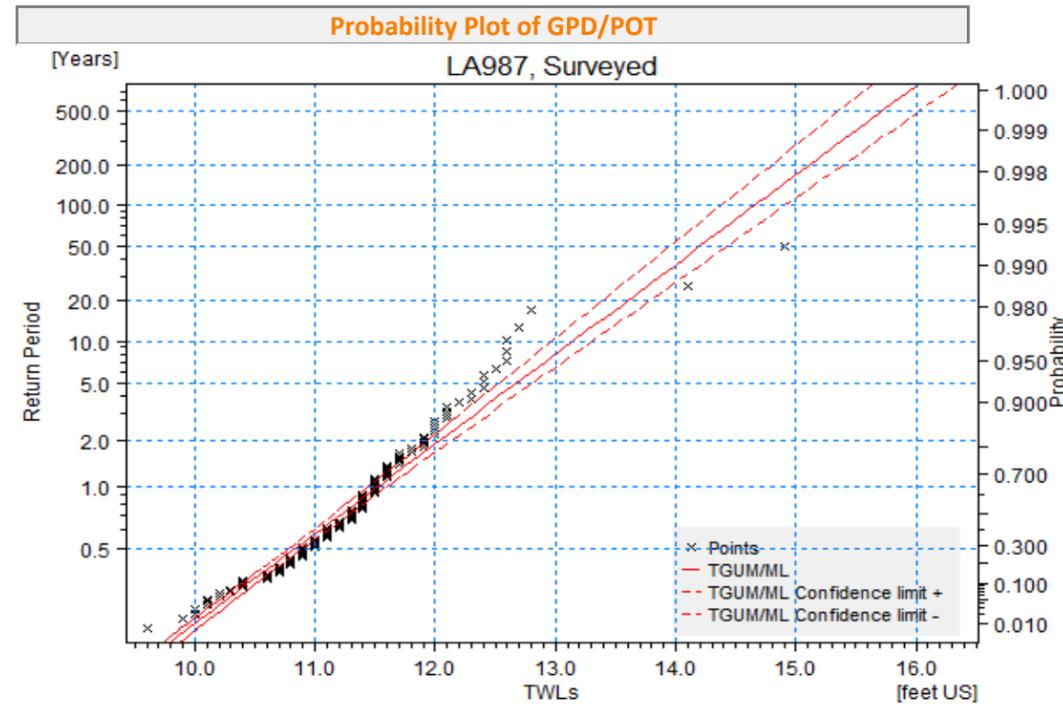


Peak	Date/Time	Stockdon									DIM						TAW										Results					Methods						
		SWL (ft NAVD)	Ho (ft)	TP (sec)	m <sub>s</sub>	n <sub>bar</sub> (ft)	sigma <sub>IG</sub> (ft)	sigma <sub>inc</sub> (ft)	DWL2% (ft NAVD)	TWL <sub>s</sub> (ft NAVD)	Gamma	m <sub>dim</sub>	n <sub>bar</sub> (ft)	sigma <sub>IG</sub> (ft)	sigma <sub>inc</sub> (ft)	DWL2% <sub>DIM</sub> (ft NAVD)	TWL <sub>DIM</sub> (ft NAVD)	d <sub>10%</sub> (ft)	H <sub>10%</sub> (ft)	T <sub>m-1.0</sub> (sec)	m <sub>TAW</sub>	I <sub>r,TAW</sub>	Rough. Factor	VWRF	n <sub>bar</sub> (ft)	n <sub>bar</sub> <sub>red</sub> (ft)	n <sub>bar</sub> factor	sigma <sub>IG</sub> (ft)	sigma <sub>inc</sub> (ft)	TWL <sub>TAW</sub> (ft NAVD)	n <sub>bar</sub> (ft)	sigma <sub>IG</sub> (ft)	sigma <sub>inc</sub> (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
1	1/29/83 9:00	7.3	7.6	11.9	0.127					2.5	0.0601	1.7	1.4	1.3	11.7	12.8	1.89	1.47	9.7	0.0884	0.9	1.0	1.0000	1.7	1.7	1.00	1.4	1.4	14.9	1.7	1.4	1.4	11.7	14.9	0	0	1	
2	3/1/83 23:00	6.0	12.3	11.9	0.127					1.0	0.0453	2.4	1.6	1.3	11.6	12.5	1.80	1.41	10.7	0.0889	1.0	1.0	1.0000	2.4	2.4	1.00	1.6	2.2	14.1	2.4	1.6	2.2	11.6	14.1	0	0	1	
3	5/14/80 21:00	6.8	6.2	17.5	0.127					1.0	0.0561	1.7	1.1	1.7	10.8	12.5	0.93	0.73	11.0	0.0888	1.4	1.0	1.0000	1.7	1.7	1.00	1.1	1.2	12.0	1.7	1.1	1.7	10.8	12.5	0	1	0	
4	2/3/98 2:00	5.8	11.3	9.8	0.127					2.1	0.0513	2.1	1.6	1.1	11.2	11.9	1.32	1.03	8.8	0.0896	1.0	1.0	1.0000	2.1	2.1	1.00	1.6	1.6	12.7	2.1	1.6	1.6	11.2	12.7	0	0	1	
5	1/17/88 8:00	6.7	8.2	6.7	0.127					10.8	0.0700	1.5	1.5	0.9	11.2	11.7	1.34	1.04	6.2	0.0892	0.7	1.0	1.0000	1.5	1.5	1.00	1.5	1.1	12.8	1.5	1.5	1.1	11.2	12.8	0	0	1	
6	3/1/78 2:00	5.8	10.2	8.1	0.127					7.6	0.0535	1.8	1.7	0.9	11.1	11.5	1.21	0.95	7.1	0.0901	0.8	1.0	1.0000	1.8	1.8	1.00	1.7	1.3	12.4	1.8	1.7	1.3	11.1	12.4	0	0	1	
7	1/2/06 10:00	6.5	8.3	8.1	0.127					6.2	0.0617	1.6	1.4	1.0	11.0	11.6	1.15	0.90	6.8	0.0893	0.8	1.0	1.0000	1.6	1.6	1.00	1.4	1.3	12.3	1.6	1.4	1.3	11.0	12.3	0	0	1	
8	8/16/82 19:00	6.9	5.0	19.2	0.127					1.0	0.0628	1.5	1.0	1.8	10.4	12.6	0.61	0.48	16.4	0.0886	2.6	1.0	1.0000	1.5	1.5	1.00	1.0	0.8	11.1	1.5	1.0	1.8	10.4	12.6	0	1	0	
9	6/8/68 19:00	6.3	7.1	15.9	0.127					1.0	0.0524	1.8	1.2	1.5	10.5	12.0	0.66	0.52	12.7	0.0894	2.0	1.0	1.0000	1.8	1.8	1.00	1.2	0.9	11.2	1.8	1.2	1.5	10.5	12.0	0	1	0	
10	8/24/65 19:00	6.8	6.0	14.4	0.127					1.0	0.0606	1.5	1.0	1.5	10.4	11.9	0.59	0.46	12.6	0.0887	2.1	1.0	1.0000	1.5	1.5	1.00	1.0	0.8	11.0	1.5	1.0	1.5	10.4	11.9	0	1	0	
11	2/14/80 7:00	6.9	7.1	9.8	0.127					1.4	0.0630	1.5	1.1	1.1	10.6	11.5	0.77	0.60	8.3	0.0886	1.2	1.0	1.0000	1.5	1.5	1.00	1.1	1.0	11.4	1.5	1.1	1.1	10.6	11.5	0	1	0	
12	2/9/78 23:00	6.3	8.4	7.4	0.127					6.8	0.0620	1.6	1.4	0.9	10.7	11.2	0.88	0.68	6.7	0.0890	0.9	1.0	1.0000	1.6	1.6	1.00	1.4	1.4	11.5	1.6	1.4	1.4	10.7	11.5	0	0	1	
13	3/20/92 22:00	6.8	5.0	19.2	0.127					1.4	0.0628	1.5	1.1	1.8	10.5	12.6	0.62	0.49	7.6	0.0889	1.2	1.0	1.0000	1.5	1.5	1.00	1.1	0.8	11.0	1.5	1.1	1.8	10.5	12.6	0	1	0	
14	2/17/80 10:00	6.6	6.1	13.1	0.127					1.0	0.0606	1.5	1.0	1.3	10.1	11.5	0.31	0.24	10.5	0.0889	2.4	1.0	1.0000	1.5	1.5	1.00	1.0	0.4	10.3	1.5	1.0	1.3	10.1	11.5	0	1	0	
15	2/8/93 10:00	6.7	7.4	8.9	0.127					1.0	0.0612	1.5	1.0	1.0	10.3	11.1	0.41	0.32	8.2	0.0888	1.6	1.0	1.0000	1.5	1.5	1.00	1.0	0.5	10.5	1.5	1.0	1.0	10.3	11.1	0	1	0	
16	6/14/95 22:00	6.4	5.2	19.2	0.127					1.0	0.0583	1.5	1.0	1.7	10.0	12.0	0.17	0.13	16.3	0.0881	5.0	1.0	1.0000	1.5	1.5	1.00	1.0	0.2	10.0	1.5	1.0	1.7	10.0	12.0	0	1	0	
17	7/2/08 20:00	7.2	3.8	19.2	0.127					1.0	0.0752	1.3	0.8	1.9	10.2	12.6	0.31	0.25	12.0	0.0880	2.7	1.0	1.0000	1.3	1.3	1.00	0.8	0.4	10.4	1.3	0.8	1.9	10.2	12.6	0	1	0	
18	8/17/05 19:00	6.6	5.2	15.9	0.127					1.0	0.0633	1.4	1.0	1.6	10.0	11.7	0.16	0.13	14.6	0.0879	4.5	1.0	1.0000	1.4	1.4	1.00	1.0	0.2	10.0	1.4	1.0	1.6	10.0	11.7	0	1	0	
19	11/30/82 8:00	7.9	4.6	6.1	0.127					4.9	0.0838	0.9	0.8	0.7	10.5	11.1	0.65	0.51	6.3	0.0856	0.9	1.0	1.0000	0.9	0.9	1.00	0.8	1.5	11.3	0.9	0.8	1.5	10.5	11.3	0	0	1	
20	1/10/78 9:00	7.0	4.6	15.9	0.127					1.0	0.0702	1.3	0.9	1.6	10.1	12.1	0.31	0.24	9.0	0.0883	2.0	1.0	1.0000	1.3	1.3	1.00	0.9	0.4	10.3	1.3	0.9	1.6	10.1	12.1	0	1	0	
21	11/14/97 8:00	7.3	3.8	17.5	0.127					1.0	0.0758	1.2	0.8	1.8	10.2	12.4	0.31	0.24	11.2	0.0880	2.5	1.0	1.0000	1.2	1.2	1.00	0.8	0.4	10.4	1.2	0.8	1.8	10.2	12.4	0	1	0	
22	6/28/81 18:00	6.4	5.6	15.9	0.127					1.0	0.0590	1.5	1.0	1.5	10.0	11.6	0.12	0.09	14.5	0.0881	5.2	1.0	1.0000	1.5	1.5	1.00	1.0	0.2	10.0	1.5	1.0	1.5	10.0	11.6	0	1	0	
23	7/29/85 19:00	6.8	4.7	15.9	0.127					1.0	0.0683	1.4	0.9	1.6	10.0	11.8	0.15	0.11	12.1	0.0877	3.9	1.0	1.0000	1.4	1.4	1.00	0.9	0.2	10.0	1.4	0.9	1.6	10.0	11.8	0	1	0	
24	12/17/87 6:00	6.2	7.4	11.9	0.127					1.0	0.0539	1.7	1.1	1.2	10.1	11.1	0.25	0.20	9.6	0.0887	2.4	1.0	1.0000	1.7	1.7	1.00	1.1	0.3	10.2	1.7	1.1	1.2	10.1	11.1	0	1	0	
25	1/8/74 8:00	7.3	4.9	8.9	0.127					2.2	0.0755	1.1	0.9	1.0	10.2	11.1	0.33	0.26	7.4	0.0880	1.6	1.0	1.0000	1.1	1.1	1.00	0.9	0.4	10.4	1.1	0.9	1.0	10.2	11.1	0	1	0	
26	6/3/04 21:00	6.8	4.3	17.5	0.127					1.0	0.0694	1.3	0.9	1.7	9.9	12.0	0.05	0.04	14.7	0.0875	7.9	1.0	1.0000	1.3	1.3	1.00	0.9	0.1	9.9	1.3	0.9	1.7	9.9	12.0	0	1	0	
27	11/29/70 9:00	6.4	6.3	8.1	0.127					7.7	0.0720	1.3	1.2	1.0	10.2	10.9	0.36	0.28	6.7	0.0893	1.4	1.0	1.0000	1.3	1.3	1.00	1.2	0.5	10.3	1.3	1.2	1.0	10.2	10.9	0	1	0	
28	9/3/67 20:00	6.4	5.8	14.4	0.127					1.0	0.0595	1.5	1.0	1.4	9.9	11.4	0.08	0.07	13.6	0.0881	5.8	1.0	1.0000	1.5	1.5	1.00	1.0	0.1	9.9	1.5	1.0	1.4	9.9	11.4	0	1	0	
29	12/28/04 9:00	6.3	6.6	8.1	0.127					7.5	0.0695	1.4	1.3	1.0	10.2	10.9	0.36	0.28	6.8	0.0894	1.4	1.0	1.0000	1.4	1.4	1.00	1.3	0.5	10.4	1.4	1.3	1.0	10.2	10.9	0	1	0	
30	9/16/05 20:00	6.0	5.8	17.5	0.127					1.0	0.0547	1.6	1.1	1.6	9.7	11.4																						
31	5/11/80 19:00	5.7	4.9	23.3	0.127					1.0	0.0553	1.6	1.1	1.9	9.4	11.7																						
32	6/30/73 21:00	6.8	3.6	21.2	0.127					1.0	0.0733	1.2	0.8	2.0	9.7	12.4																						
33	6/21/05 20:00	6.6	4.9	14.4	0.127					1.0	0.0679	1.3	0.9	1.5	9.8	11.4																						
34	4/25/98 20:00	6.0	4.4	23.3	0.127					1.0	0.0604	1.5	1.0	2.0	9.4	11.9																						
35	10/26/03 9:00	6.7	3.9	19.2	0.127					1.0	0.0719	1.3	0.9	1.9	9.7	12.1																						
36	6/2/97 19:00	6.6	4.8	14.4	0.127					1.0	0.0685	1.3	0.9	1.5	9.7	11.4																						
37	7/19/66 22:00	6.5	5.1	14.4	0.127					1.0	0.0664	1.4	0.9	1.5	9.8	11.4																						
38	6/15/65 21:00	5.7	4.4	23.3	0.127					1.0	0.0598	1.5	1.0	2.0	9.1	11.6																						
39	8/23/72 20:00	6.2	5.7	14.4	0.127					1.0	0.0598	1.5	1.0	1.4	9.7	11.1																						
40	7/23/09 22:00	6.5	4.3	19.2	0.127					1.0	0.0676	1.4	0.9	1.8	9.7	11.9																						
41	5/22/63 20:00	6.3	4.5	19.2	0.127					1.0	0.0649	1.4	0.9	1.8	9.6</																							



Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
56	7/7/1960 20:00	11.5	15.3
92	4/25/1963 22:00	11.1	14.7
41	5/22/1963 20:00	11.8	15.9
91	5/26/1963 22:00	10.6	14.7
139	12/20/1964 9:00	10.8	14.1
117	5/3/1965 22:00	11.3	14.3
38	6/15/1965 21:00	11.6	16.0
10	8/24/1965 19:00	11.9	18.7
37	7/19/1966 22:00	11.4	16.2
131	4/21/1967 19:00	10.3	14.2
53	5/25/1967 22:00	12.2	15.4
28	9/3/1967 20:00	11.4	16.7
89	5/12/1968 21:00	10.9	14.8
58	5/21/1968 18:00	10.7	15.3
9	6/8/1968 19:00	12.0	18.8
85	1/19/1969 9:00	10.1	14.9
60	8/25/1969 19:00	11.6	15.3
63	9/15/1969 11:00	11.0	15.2
109	9/20/1969 16:00	10.7	14.5
82	12/9/1969 8:00	10.9	14.9
66	4/11/1970 21:00	9.9	15.2
27	11/29/1970 9:00	10.9	16.8
111	4/24/1971 20:00	11.3	14.5
132	6/10/1972 20:00	10.9	14.2
71	8/17/1972 18:00	10.2	15.1
39	8/23/1972 20:00	11.1	16.0
116	1/19/1973 9:00	10.8	14.3
32	6/30/1973 21:00	12.4	16.5
80	7/27/1973 19:00	11.6	15.0
55	8/23/1973 17:00	11.2	15.3
25	1/8/1974 8:00	11.1	16.9
101	12/28/1974 8:00	10.0	14.6
93	5/20/1975 18:00	10.8	14.7
20	1/10/1978 9:00	12.1	17.2
106	2/6/1978 8:00	11.2	14.5
12	2/9/1978 23:00	11.5	18.3
6	3/1/1978 2:00	12.4	19.1
100	3/5/1978 6:00	10.6	14.6
113	6/13/1979 23:00	11.2	14.5
11	2/14/1980 7:00	11.5	18.5
14	2/17/1980 10:00	11.5	17.7
31	5/11/1980 19:00	11.7	16.6

Extreme Analysis Results				
Return Period (year)	Estimated Extreme TWLs (ft NAVD)		Standard Deviation of Estimated Extremes (ft)	
	GPD/POT	GEV/AM	GPD/POT	GEV/AM
50	14.2		0.2	
100	14.7		0.3	
500	15.7		0.3	



\*TGUM/ML stands for Truncated Gumbel Distribution with Maximum Likelihood Estimation Method.

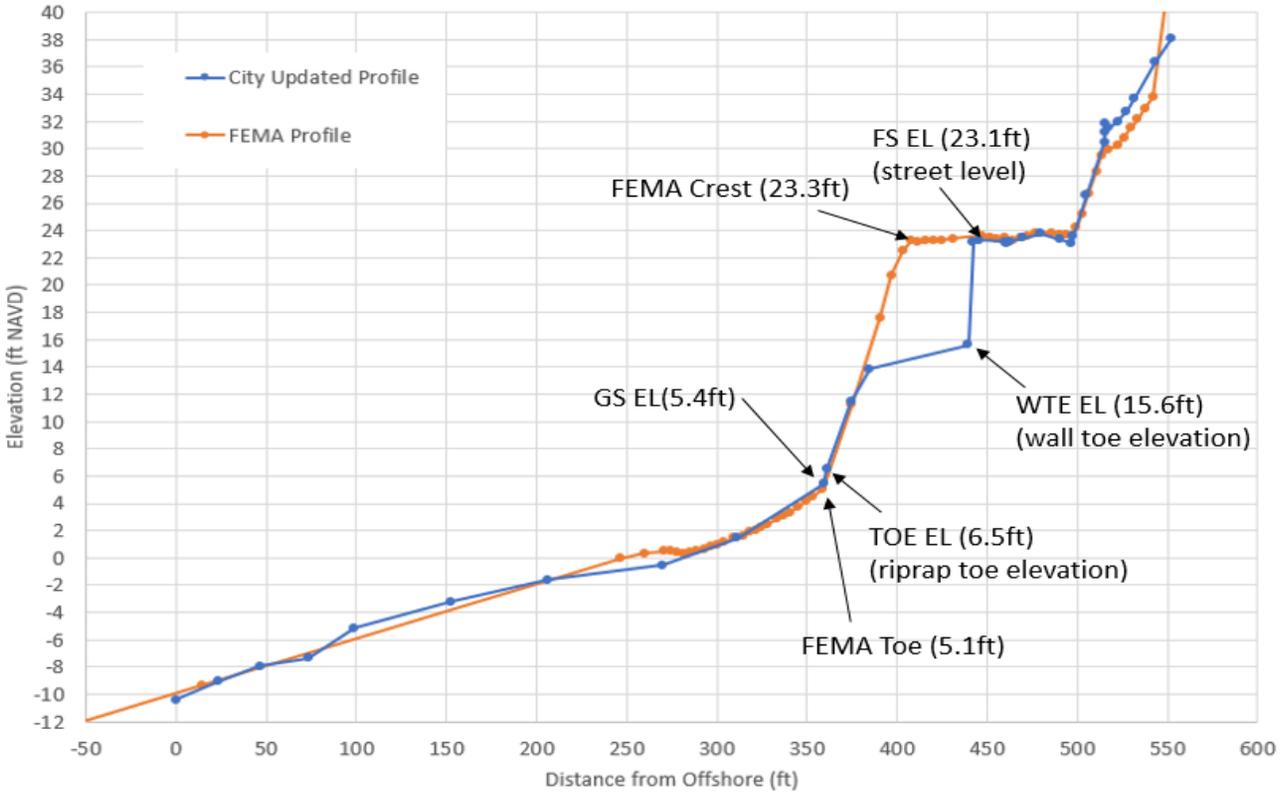
Generalised Pareto Distribution with Maximum Likelihood Estimation Method does not fit as well as Truncated Gumbel Distribution.

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
3	5/14/1980 21:00	12.5	19.5
65	1/20/1981 9:00	11.1	15.2
22	6/28/1981 18:00	11.6	17.1
8	8/16/1982 19:00	12.6	18.9
19	11/30/1982 8:00	11.3	17.3
1	1/29/1983 9:00	14.9	21.8
2	3/1/1983 23:00	14.1	21.2
76	6/11/1983 21:00	11.1	15.0
110	8/8/1983 21:00	11.3	14.5
72	6/2/1985 20:00	11.3	15.1
81	7/3/1985 21:00	11.5	14.9
70	7/16/1985 20:00	11.3	15.1
23	7/29/1985 19:00	11.8	17.1
48	11/12/1985 8:00	12.3	15.5
119	7/10/1987 20:00	11.4	14.3
118	10/3/1987 18:00	11.3	14.3
57	10/8/1987 9:00	11.4	15.3
24	12/17/1987 6:00	11.1	17.0
5	1/17/1988 8:00	12.8	19.4
43	5/4/1989 20:00	12.0	15.8
125	5/8/1989 23:00	11.5	14.2
79	6/21/1989 22:00	11.0	15.0
103	7/18/1989 21:00	11.2	14.6
47	2/28/1991 9:00	10.4	15.5
138	5/27/1991 20:00	10.8	14.1
123	6/24/1991 19:00	10.6	14.2
134	7/12/1991 21:00	11.3	14.1
13	3/20/1992 22:00	12.6	18.1
124	4/17/1992 21:00	11.6	14.2
137	12/7/1992 7:00	10.0	14.1
62	1/7/1993 8:00	10.4	15.2
50	1/18/1993 6:00	10.9	15.4
15	2/8/1993 10:00	11.1	17.7
64	2/19/1993 8:00	10.4	15.2
135	6/4/1993 21:00	11.7	14.1
126	7/17/1993 19:00	11.5	14.2
112	12/15/1993 10:00	11.7	14.5
97	4/25/1994 21:00	11.4	14.6
95	1/3/1995 10:00	10.9	14.7
16	6/14/1995 22:00	12.0	17.5
86	6/30/1996 20:00	11.5	14.8
52	7/26/1996 18:00	11.0	15.4

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
75	4/9/1997 21:00	10.7	15.0
36	6/2/1997 19:00	11.4	16.2
88	6/21/1997 21:00	11.5	14.8
69	8/2/1997 20:00	11.6	15.1
120	8/15/1997 19:00	11.7	14.3
44	10/3/1997 10:00	11.3	15.7
21	11/14/1997 8:00	12.4	17.2
77	1/29/1998 10:00	11.4	15.0
4	2/3/1998 2:00	12.7	19.5
49	2/7/1998 6:00	10.7	15.5
51	2/24/1998 7:00	11.4	15.4
34	4/25/1998 20:00	11.9	16.3
83	5/25/1998 21:00	12.1	14.9
104	6/11/1998 22:00	11.2	14.5
96	7/11/1998 22:00	11.6	14.6
128	8/3/1998 18:00	10.9	14.2
102	8/6/1998 20:00	11.1	14.6
61	10/2/1998 19:00	10.8	15.3
107	2/17/1999 10:00	11.0	14.5
45	5/15/1999 21:00	11.9	15.7
114	6/3/1999 23:00	10.1	14.4
54	10/6/1999 19:00	11.0	15.4
90	1/11/2001 10:00	10.1	14.8
94	7/20/2001 21:00	11.4	14.7
98	9/7/2002 21:00	11.6	14.6
59	4/18/2003 22:00	11.9	15.3
84	5/3/2003 21:00	10.4	14.9
105	5/15/2003 20:00	11.4	14.5
35	10/26/2003 9:00	12.1	16.3
122	5/4/2004 21:00	11.0	14.3
115	5/7/2004 23:00	11.7	14.4
26	6/3/2004 21:00	12.0	16.8
129	9/19/2004 12:00	11.0	14.2
29	12/28/2004 9:00	10.9	16.6
67	1/9/2005 8:00	10.3	15.2
73	2/21/2005 7:00	10.4	15.1
33	6/21/2005 20:00	11.4	16.4
99	7/21/2005 21:00	11.5	14.6
18	8/17/2005 19:00	11.7	17.4
30	9/16/2005 20:00	11.4	16.6
7	1/2/2006 10:00	12.3	19.0
74	5/27/2006 21:00	12.0	15.1

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
130	10/21/2006 8:00	10.9	14.2
121	4/11/2007 1:00	9.6	14.3
127	5/3/2007 21:00	10.7	14.2
136	5/19/2007 23:00	11.4	14.1
78	2/24/2008 23:00	10.2	15.0
108	4/19/2008 21:00	10.6	14.5
87	6/4/2008 21:00	11.2	14.8
17	7/2/2008 20:00	12.6	17.4
68	7/30/2008 19:00	11.1	15.1
46	9/4/2008 11:00	11.0	15.7
133	11/9/2008 6:00	10.8	14.1
42	2/7/2009 7:00	12.1	15.8
40	7/23/2009 22:00	11.9	16.0

# Transect #28/946

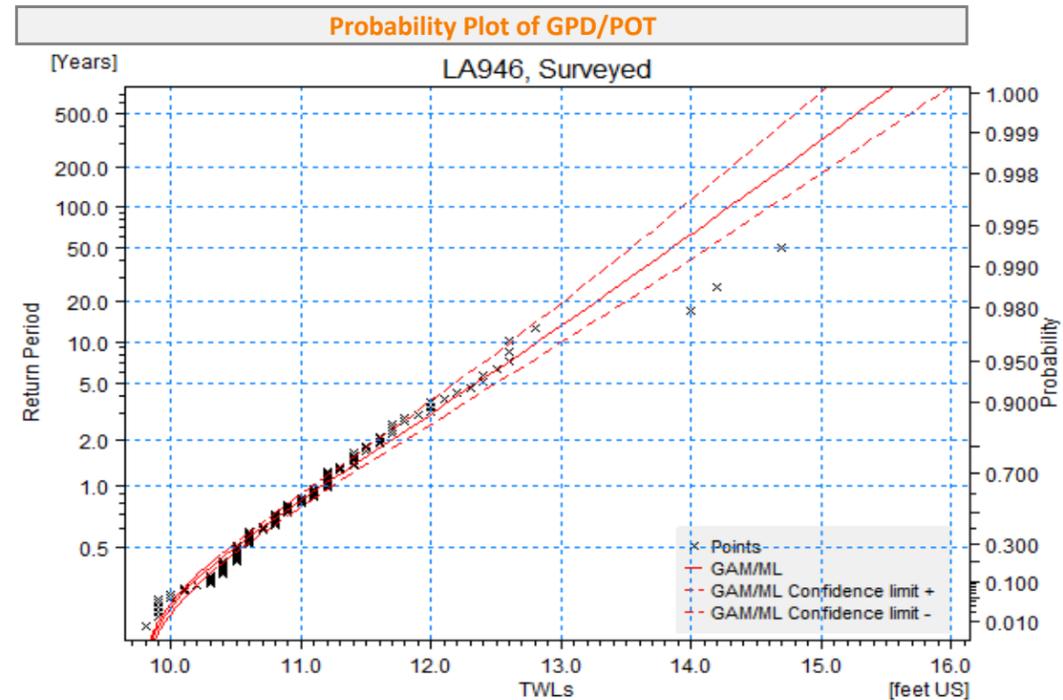






Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
73	7/7/1960 20:00	10.9	19.0
120	3/6/1962 9:00	9.9	18.0
74	2/10/1963 23:00	10.8	19.0
77	4/25/1963 22:00	10.8	18.9
100	5/22/1963 20:00	10.8	18.4
134	6/15/1965 21:00	11.2	17.7
16	8/24/1965 19:00	11.9	22.7
41	7/19/1966 22:00	11.2	20.4
28	9/3/1967 20:00	11.4	21.1
84	5/12/1968 21:00	10.5	18.8
7	6/8/1968 19:00	12.4	23.5
111	1/21/1969 11:00	9.9	18.1
114	8/25/1969 19:00	10.5	18.1
33	9/16/1969 11:00	11.1	20.7
53	9/20/1969 16:00	10.9	19.9
68	12/7/1969 7:00	10.8	19.2
137	12/10/1969 9:00	9.9	17.7
49	11/29/1970 9:00	10.6	20.1
99	7/21/1971 20:00	10.4	18.4
96	8/4/1971 19:00	10.5	18.5
128	6/10/1972 20:00	10.3	17.8
94	8/17/1972 15:00	10.6	18.5
36	8/23/1972 20:00	11.1	20.6
46	1/19/1973 9:00	11.4	20.2
67	6/30/1973 21:00	11.4	19.3
130	7/27/1973 19:00	10.1	17.8
126	8/18/1973 12:00	10.0	17.8
44	8/23/1973 17:00	11.3	20.3
29	1/8/1974 8:00	11.3	21.1
112	12/28/1974 8:00	9.8	18.1
113	4/26/1975 21:00	10.6	18.1
38	5/20/1975 18:00	11.2	20.4
18	1/10/1978 9:00	12.2	22.6
107	2/6/1978 8:00	10.6	18.3
14	2/10/1978 0:00	11.6	22.9
19	3/1/1978 2:00	11.4	22.5
17	3/5/1978 6:00	12.0	22.6
119	1/6/1979 4:00	10.1	18.0
55	12/31/1979 7:00	11.0	19.9
12	2/14/1980 7:00	12.0	23.0
5	2/17/1980 10:00	12.8	25.3

Extreme Analysis Results				
Return Period (year)	Estimated Extreme TWLs (ft NAVD)		Standard Deviation of Estimated Extremes (ft)	
	GPD/POT	GEV/AM	GPD/POT	GEV/AM
50	13.9		0.3	
100	14.3		0.3	
500	15.3		0.4	



\*GAM/ML stands for Gammar/Pearson Type 3 Distribution with Maximum Likelihood Estimation Method.

Generalised Pareto Distribution with Maximum Likelihood Estimation Method provides very similar results for 100-yr TWL.

**Input Data for Extreme Analysis**

No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
51	2/21/1980 1:00	10.8	20.0
82	5/11/1980 19:00	11.5	18.8
10	5/14/1980 21:00	12.6	23.1
11	1/20/1981 9:00	12.3	23.0
21	6/28/1981 18:00	11.6	21.7
136	11/13/1981 9:00	10.3	17.7
42	8/17/1982 20:00	11.2	20.3
76	9/27/1982 17:00	10.7	18.9
9	12/1/1982 8:00	12.6	23.2
2	1/27/1983 8:00	14.0	28.5
32	1/30/1983 10:00	11.2	20.7
40	2/13/1983 9:00	11.1	20.4
1	3/1/1983 23:00	14.7	31.5
89	3/17/1983 23:00	10.5	18.6
139	8/8/1983 21:00	10.4	17.7
69	6/2/1985 20:00	11.0	19.2
129	7/3/1985 22:00	10.6	17.8
70	7/16/1985 20:00	10.7	19.2
35	7/29/1985 19:00	11.5	20.6
63	11/12/1985 8:00	11.7	19.3
39	2/15/1986 1:00	11.4	20.4
91	3/11/1986 9:00	10.4	18.6
88	10/8/1987 9:00	10.5	18.7
13	12/17/1987 6:00	11.8	22.9
3	1/18/1988 8:00	14.2	28.4
132	4/17/1988 21:00	10.4	17.8
133	5/4/1989 20:00	10.0	17.7
98	6/21/1989 22:00	10.6	18.4
85	7/18/1989 21:00	10.7	18.8
110	8/16/1989 20:00	10.5	18.2
121	4/24/1990 20:00	10.6	18.0
45	3/1/1991 9:00	10.8	20.3
59	6/24/1991 19:00	10.8	19.5
60	1/19/1992 8:00	11.4	19.5
64	2/11/1992 2:00	10.5	19.3
108	3/20/1992 22:00	9.9	18.2
123	12/7/1992 7:00	9.9	17.9
75	1/7/1993 8:00	10.3	18.9
30	1/18/1993 6:00	11.2	21.0
34	2/5/1993 8:00	11.3	20.7
8	2/8/1993 11:00	12.4	23.3
62	2/19/1993 8:00	10.4	19.4

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
124	6/5/1993 21:00	10.7	17.9
117	11/12/1993 7:00	10.9	18.0
87	4/25/1994 20:00	11.1	18.7
24	1/3/1995 10:00	11.7	21.5
37	1/11/1995 5:00	10.9	20.5
72	3/12/1995 6:00	10.8	19.1
31	6/15/1995 23:00	11.5	20.7
115	2/18/1996 8:00	10.4	18.0
135	6/30/1996 20:00	10.3	17.7
50	7/26/1996 18:00	11.1	20.0
56	6/2/1997 19:00	11.0	19.8
92	6/21/1997 21:00	10.8	18.6
97	8/2/1997 20:00	10.9	18.5
138	8/15/1997 19:00	10.7	17.7
86	10/3/1997 10:00	10.9	18.8
26	11/14/1997 8:00	12.0	21.2
57	12/7/1997 3:00	10.4	19.7
104	1/27/1998 8:00	10.5	18.3
22	1/30/1998 10:00	11.8	21.6
4	2/3/1998 3:00	12.6	25.7
6	2/7/1998 6:00	12.5	24.2
27	2/24/1998 7:00	11.7	21.2
78	4/25/1998 20:00	11.7	18.9
93	8/6/1998 20:00	10.5	18.6
122	10/3/1998 19:00	10.5	17.9
65	5/15/1999 21:00	11.4	19.3
20	1/11/2001 10:00	12.1	22.2
116	7/20/2001 21:00	10.6	18.0
103	11/8/2002 11:00	10.9	18.3
43	12/17/2002 7:00	11.2	20.3
102	5/15/2003 20:00	10.8	18.4
118	10/26/2003 9:00	10.5	18.0
125	12/24/2003 9:00	10.5	17.9
95	5/4/2004 21:00	10.5	18.5
48	6/4/2004 22:00	11.2	20.1
54	12/28/2004 9:00	10.6	19.9
80	1/8/2005 7:00	10.3	18.9
71	2/21/2005 7:00	10.2	19.2
106	6/6/2005 20:00	10.6	18.3
52	6/21/2005 20:00	11.0	19.9
23	8/17/2005 19:00	11.6	21.5
58	9/16/2005 20:00	11.0	19.5

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with city surveyed profile) (ft NAVD)	PFIRM TWL (ft NAVD)
15	1/2/2006 10:00	11.6	22.8
81	5/25/2006 19:00	10.9	18.8
109	6/25/2006 21:00	10.3	18.2
83	10/23/2007 7:00	10.1	18.8
105	12/5/2007 6:00	10.5	18.3
90	2/24/2008 23:00	10.6	18.6
127	5/21/2008 21:00	10.4	17.8
101	6/4/2008 21:00	10.6	18.4
47	7/3/2008 21:00	11.2	20.1
66	7/31/2008 20:00	11.1	19.3
25	9/4/2008 11:00	11.2	21.3
131	12/25/2008 7:00	10.4	17.8
61	2/7/2009 7:00	11.2	19.4
79	7/23/2009 22:00	11.1	18.9

## Appendix C. Los Angeles County Detailed TWL Results

### Worksheet Key

#### General Output

- A. Ranked peaks from POT analysis
- B. Date/Time of peak (PST)
- C. Stillwater level at time of TWL peak (SWL)
- D. Deepwater equivalent wave height at time of peak ( $H_0$ )
- E. Peak period of the deepwater equivalent spectrum ( $T_p$ )

#### Stockdon Output

- F. Foreshore beach slope ( $m_f$ )
- G. Static wave setup at time of TWL peak ( $\eta_{bar}$ ) (Equation 4.3-12)
- H. Dynamic wave setup (infragravity oscillation) at time of peak ( $\sigma_{IG}$ ) (Equation 4.3-13)
- I. Incident wave runup at time of peak ( $\sigma_{inc}$ ) (Equation 4.3-14)
- J. DWL2% at time of peak (Equation 4.3-15)
- K. TWL at time of peak ( $TWL_S$ ) (Equation 4.3-16)

$$TWL_S = SWL + 1.1 \left[ 0.35m_f \sqrt{H_0 L_0} + \frac{\sqrt{[H_0 L_0 (0.563m_f^2 + 0.004)]}}{2} \right]$$

$$TWL_S = SWL + 0.043 \sqrt{H_0 L_0}$$

#### DIM Output

- L. Gamma of the deepwater equivalent spectrum
- M. Nearshore slope ( $m$ )
- N. Static wave setup at time of TWL peak ( $\eta_{bar}$ ) (Equation 4.3-2)
- O. Dynamic wave setup (infragravity oscillation) at time of peak ( $\sigma_1$ ) (Equation 4.3-3)
- P. Incident wave runup at time of peak ( $\sigma_2$ ) (Equation 4.3-4 or Equation 4.3-18 if  $\xi_{Op,DIM} > \xi_{OCrit}$ )
- Q. DWL2% at time of peak from DIM method (Equation 4.3-9)
- R. TWL at time of peak ( $TWL_{DIM}$ ) (Equation 4.3-10 and 4.3-11)

DIM runup is calculated with the DIM Iribarren Number:  $\xi_{Op,DIM}$

$$TWL_{DIM} = SWL + \bar{\eta} + 2\sqrt{\sigma_1^2 + \sigma_2^2}$$

Spreadsheet Formula:  $TWL_{DIM} = C + n+2*\text{sqrt}(O^2 + P^2)$

#### TAW Output

- S. Water depth at the toe (relative to DWL2%) ( $d_{toe}$ )
- T. Significant wave height at the toe of bluff/structure ( $H_{toe}$ ) (Depth limited or Equation 4.3-20)
- U. Spectral wave period ( $T_{m-1.0}$ )
- V. TAW wave runup slope ( $m_{TAW}$ )
- W. TAW Iribarren number ( $Ir_{TAW}$ ) (Eq. 4.3-21)
- X. Roughness factor ( $\gamma_r$ ) (Table 15)
- Y. Vertical wall reduction factor ( $\gamma_v$ ) (Equation 4.3-22)
- Z. Static wave setup at time of TWL peak ( $\eta_{bar}$ ) (from DIM)
- AA. Reduced static wave setup at time of peak ( $\bar{\eta}'$ )
- AB. Static wave setup reduction factor ( $\gamma_{\eta}$ )
- AC. Dynamic wave setup (infragravity oscillation) at time of peak ( $\sigma_1$ ) (from DIM)
- AD. Incident wave runup at time of peak ( $\sigma_2=R/2$ ) (R from Equation 4.3-19)
- AE. TWL at time of peak ( $TWL_{TAW}'$ ) (Equation 4.3-28)

TAW runup is calculated with the TAW Iribarren Number:  $\xi_{Om}$

$$TWL_{TAW}' = SWL + \bar{\eta}' + 2.0\sqrt{\sigma_1^2 + \sigma_2^2}$$

Spreadsheet Formula:  $TWL_{TAW} = C + AA+2*\text{sqrt}(AC^2 + AD^2)$

### *Results*

- AF. Static wave setup at time of TWL peak ( $\eta_{\text{bar}}$ )
- AG. Dynamic wave setup (infragravity oscillation) at time of peak ( $\sigma_{IG}$  or  $\sigma_1$ )
- AH. Incident wave runup at time of peak ( $\sigma_{\text{inc}}$  or  $\sigma_2$ )
- AI. *DWL2%* at time of peak (including static setup reduction, if applicable)
- AJ. TWL at time of peak ( $TWL_S$  or  $TWL_{DIM}$  or  $TWL_{TAW}'$ )

### *Method Indicators*

- AK. Stockdon method indicator (0 or 1)
- AL. DIM method indicator (0 or 1)
- AM. TAW method indicator (0 or 1 or 2 (modified TAW))

Note: Transects where a GEV/Annual Maxima extreme value analysis were conducted are indicated with a "(AM)" in the tab ID.

### *Harbor Analysis Variables*

#### *Diffraction Analysis (blank if not applicable)*

- AN. Local wavelength at harbor entrance (L)
- AO. Angle between shoreline and tip of breakwater ( $\theta$ )
- AP. Angle between incident wave and tip of breakwater ( $\theta_0$ )
- AQ. Distance from breakwater tip to shoreline (r)
- AR. Diffraction coefficient (Kd) (Eq. 4.9-3 and Appendix E)
- AS. Refraction coefficient from SHELF point to breakwater entrance (Kr)
- AT. Diffracted deepwater equivalent wave height at transect (Hd)

#### *Transmission Analysis (blank if not applicable)*

- AU. Refraction coefficient from SHELF point to breakwater toe (Kr)
- AV. Shoaling coefficient from SHELF point to breakwater toe (Ks)
- AW. Wave height at the toe of the breakwater (Htoe)
- AX. Transmission coefficient at breakwater (Kt) (Eq. 4.9-1)
- AY. Transmitted wave height at breakwater (Ht)
- AZ. Diffraction coefficient due to wave spreading in harbor (K') (Eq. 4.9-2)
- BA. Deepwater equivalent wave height at transect (Ht')

Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, $\gamma_p$	Stockdon					TAW										Results					Methods							
								$m_r$	$n_{bar}$ (ft)	$\sigma_{IG}$ (ft)	$\sigma_{inc}$ (ft)	DWL2% (ft NAVD)	TWL <sub>s</sub> (ft NAVD)	$d_{top}$ (ft)	$H_{top}$ (ft)	$T_{m-1.0}$ (sec)	$m_{TAW}$	$l_{TAW}$	Rough. Factor	VWRF	$n_{bar}$ (ft)	$n_{bar\_red}$ (ft)	$n_{bar}$ factor	$\sigma_{IG}$ (ft)	$\sigma_{inc}$ (ft)	Revised $\sigma_{inc}$ (ft)	TWL <sub>TAW</sub> (ft NAVD)	$n_{bar}$ (ft)	$\sigma_{IG}$ (ft)	Revised $\sigma_{inc}$ (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
1	3/1/83 23:00	6.0	13.5	15.9	212.0	34.7	0.91	0.1067	4.9	2.0	2.6	15.8	18.8	7.19	5.61	12.2	1.0000	11.6	0.6	0.9758	2.6	2.3	0.89	1.8	6.3	5.7	20.3	2.3	1.8	5.7	11.8	20.3	0	0	1
2	1/27/83 8:00	7.3	9.5	13.1	217.0	39.7	0.87	0.1067	3.4	1.4	1.8	14.1	16.2	6.68	5.21	10.2	1.0000	10.1	0.6	0.9758	2.0	1.4	0.69	1.3	5.8	5.0	19.1	1.4	1.3	5.0	11.3	19.1	0	0	1
3	1/18/88 8:00	6.8	10.3	11.9	217.0	39.7	0.87	0.1067	3.2	1.3	1.7	13.2	15.2	6.36	4.96	10.7	0.9669	10.5	0.6	0.9758	2.0	1.5	0.75	1.3	5.5	4.8	18.3	1.5	1.3	4.8	11.0	18.3	0	0	1
4	2/17/80 10:00	6.6	8.0	14.4	214.0	36.7	0.89	0.1067	3.5	1.4	1.9	13.5	15.6	5.72	4.46	11.3	0.9515	11.5	0.6	0.9758	1.8	1.3	0.74	1.2	5.0	4.5	17.2	1.3	1.2	4.5	10.4	17.2	0	0	1
5	2/3/98 3:00	5.7	11.4	11.9	210.0	32.7	0.92	0.1067	3.4	1.4	1.8	12.4	14.5	5.80	4.53	9.9	0.9512	10.1	0.6	0.9758	2.1	1.9	0.89	1.4	5.0	4.6	17.3	1.9	1.4	4.6	10.5	17.3	0	0	1
6	5/14/80 21:00	6.8	6.6	17.5	205.0	27.7	0.95	0.1067	3.8	1.5	2.0	14.3	16.6	5.56	4.34	8.8	0.9444	9.0	0.6	0.9758	1.7	1.2	0.70	1.1	4.8	4.6	17.3	1.2	1.1	4.6	10.2	17.3	0	0	1
7	12/17/87 6:00	6.2	8.3	11.9	211.0	33.7	0.92	0.1067	2.9	1.2	1.5	11.9	13.7	5.61	4.37	10.5	0.9417	10.7	0.6	0.9758	1.7	1.4	0.79	1.4	4.9	4.5	16.9	1.4	1.4	4.5	10.3	16.9	0	0	1
8	2/10/78 0:00	6.1	9.5	8.1	202.0	24.7	0.97	0.1067	2.1	0.8	1.1	10.2	11.6	5.74	4.48	7.1	0.9383	7.1	0.6	0.9758	1.7	1.3	0.80	1.5	4.8	4.7	17.2	1.3	1.5	4.7	10.4	17.2	0	0	1
9	1/2/06 10:00	6.5	8.7	8.1	207.0	29.7	0.94	0.1067	2.0	0.8	1.1	10.5	11.7	5.61	4.37	7.4	0.9364	7.5	0.6	0.9758	1.6	1.1	0.73	1.3	4.8	4.5	16.9	1.1	1.3	4.5	10.3	16.9	0	0	1
10	6/9/68 20:00	6.6	6.9	14.4	196.0	18.7	0.99	0.1067	3.2	1.3	1.7	12.9	14.9	5.30	4.13	9.6	0.9293	10.0	0.6	0.9758	1.6	1.2	0.71	1.1	4.6	4.5	17.1	1.2	1.1	4.5	9.9	17.1	0	0	1
11	2/7/98 6:00	5.8	8.8	14.4	215.0	37.7	0.89	0.1067	3.6	1.5	1.9	13.0	15.2	5.35	4.17	11.7	0.9282	12.0	0.6	0.9758	1.9	1.6	0.86	1.3	4.7	4.1	16.1	1.6	1.3	4.1	10.0	16.1	0	0	1
12	5/11/80 19:00	5.7	5.0	23.3	195.0	17.7	0.99	0.1067	4.4	1.8	2.4	14.4	17.1	4.32	3.37	7.8	0.9211	8.9	0.6	0.9758	1.5	1.3	0.84	1.0	3.7	3.7	14.6	1.4	1.8	2.4	14.4	17.1	1	0	0
13	12/1/82 8:00	7.2	6.1	11.9	218.0	40.7	0.86	0.1067	2.5	1.0	1.3	12.1	13.6	5.17	4.03	9.4	0.9262	9.8	0.6	0.9758	1.4	0.8	0.57	0.9	4.5	3.8	15.9	0.8	0.9	3.8	9.8	15.9	0	0	1
14	1/10/78 9:00	7.0	5.5	15.9	211.0	33.7	0.92	0.1067	3.1	1.3	1.7	13.2	15.2	5.14	4.01	9.9	0.9240	10.3	0.6	0.9758	1.4	0.9	0.60	1.0	4.5	4.1	16.3	0.9	1.0	4.1	9.8	16.3	0	0	1
15	2/14/80 7:00	6.9	7.4	9.8	202.0	24.7	0.97	0.1067	2.3	0.9	1.2	11.3	12.7	5.19	4.04	8.8	0.9236	9.2	0.6	0.9758	1.5	1.0	0.64	1.0	4.5	4.3	16.7	1.0	1.0	4.3	9.8	16.7	0	0	1
16	2/8/93 10:00	6.7	8.2	8.9	205.0	27.7	0.95	0.1067	2.2	0.9	1.2	11.0	12.3	5.20	4.05	8.9	0.9230	9.2	0.6	0.9758	1.5	1.1	0.68	1.0	4.5	4.3	16.5	1.1	1.0	4.3	9.8	16.5	0	0	1
17	3/1/78 2:00	5.8	9.1	8.1	185.0	7.7	1.00	0.1067	2.1	0.8	1.1	9.9	11.2	5.45	4.25	7.0	0.9188	7.1	0.6	0.9758	1.6	1.3	0.83	1.5	4.6	4.6	16.8	1.3	1.5	4.6	10.1	16.8	0	0	1
18	6/15/65 21:00	5.7	4.7	23.3	206.0	28.7	0.95	0.1067	4.3	1.7	2.3	14.2	16.8	4.26	3.33	7.2	0.9273	8.3	0.6	0.9758	1.4	1.2	0.83	1.0	3.6	3.5	14.1	4.3	1.7	2.3	14.2	16.8	1	0	0
19	1/8/74 8:00	7.3	5.6	9.8	206.0	28.7	0.95	0.1067	2.0	0.8	1.1	11.2	12.4	5.12	3.99	7.6	0.9185	7.9	0.6	0.9758	1.2	0.6	0.47	0.9	4.4	4.1	16.3	0.6	0.9	4.1	9.8	16.3	0	0	1
20	8/24/65 19:00	6.8	5.7	14.4	196.0	18.7	0.99	0.1067	2.9	1.2	1.6	12.6	14.4	4.98	3.88	11.8	0.9149	12.4	0.6	0.9758	1.4	0.9	0.63	1.0	4.4	4.3	16.6	0.9	1.0	4.3	9.6	16.6	0	0	1
21	1/20/81 9:00	6.9	5.5	14.4	215.0	37.7	0.89	0.1067	2.9	1.1	1.5	12.5	14.3	4.91	3.83	12.6	0.9130	13.3	0.6	0.9758	1.4	0.8	0.61	0.9	4.3	3.8	15.6	0.8	0.9	3.8	9.6	15.6	0	0	1
22	4/25/98 22:00	5.0	4.7	23.3	230.0	52.7	0.73	0.1067	4.3	1.7	2.3	13.5	16.1	3.64	2.84	7.5	0.9221	9.3	0.6	0.9758	1.4	1.3	0.94	1.0	3.1	2.3	11.4	4.3	1.7	2.3	13.5	16.1	1	0	0
23	11/14/97 8:00	7.3	4.2	15.9	206.0	28.7	0.95	0.1067	2.8	1.1	1.5	12.7	14.4	4.71	3.67	9.6	0.9054	10.2	0.6	0.9758	1.2	0.5	0.46	0.8	4.1	3.9	15.7	0.5	0.8	3.9	9.4	15.7	0	0	1
24	6/6/68 18:00	5.2	6.5	19.2	198.0	20.7	0.98	0.1067	4.1	1.7	2.2	13.5	16.0	4.38	3.42	8.6	0.9192	9.7	0.6	0.9758	1.7	1.4	0.92	1.1	3.8	3.7	14.6	4.1	1.7	2.2	13.5	16.0	1	0	0
25	6/15/95 23:00	6.0	6.3	17.5	205.0	27.7	0.95	0.1067	3.7	1.5	2.0	13.4	15.6	4.85	3.78	9.5	0.9033	10.0	0.6	0.9758	1.6	1.3	0.80	1.1	4.2	4.0	15.6	1.3	1.1	4.0	9.5	15.6	0	0	1
26	2/24/98 7:00	6.1	6.0	17.5	207.0	29.7	0.94	0.1067	3.6	1.5	1.9	13.3	15.6	4.80	3.75	9.4	0.9023	9.9	0.6	0.9758	1.6	1.2	0.77	1.1	4.2	3.9	15.5	1.2	1.1	3.9	9.5	15.5	0	0	1
27	1/18/93 6:00	6.4	6.5	11.9	217.0	39.7	0.87	0.1067	2.6	1.0	1.4	11.5	13.1	4.76	3.71	8.9	0.9017	9.4	0.6	0.9758	1.4	1.0	0.71	1.0	4.1	3.6	14.9	1.0	1.0	3.6	9.4	14.9	0	0	1
28	3/5/78 6:00	5.8	7.6	13.1	216.0	38.7	0.88	0.1067	3.0	1.2	1.6	11.8	13.7	4.81	3.75	10.3	0.9014	10.9	0.6	0.9758	1.7	1.4	0.84	1.1	4.2	3.7	14.9	1.4	1.1	3.7	9.5	14.9	0	0	1
29	1/30/83 10:00	6.9	4.6	11.9	218.0	40.7	0.86	0.1067	2.1	0.9	1.2	11.2	12.5	4.64	3.62	10.3	0.8991	11.0	0.6	0.9758	1.1	0.6	0.51	0.9	4.0	3.5	14.6	0.6	0.9	3.5	9.3	14.6	0	0	1
30	2/28/91 9:00	6.0	7.9	8.9	201.0	23.7	0.97	0.1067	2.1	0.9	1.1	10.2	11.6	4.79	3.74	8.1	0.8985	8.5	0.6	0.9758	1.5	1.2	0.78	1.1	4.1	4.0	15.5	1.2	1.1	4.0	9.4	15.5	0	0	1
31	5/3/03 21:00	4.8	5.4	21.2	205.0	27.7	0.95	0.1067	4.2	1.7	2.2	13.1	15.7	3.72	2.90	8.7	0.9244	10.7	0.6	0.9758	1.5	1.5	0.98	1.0	3.2	3.1	12.8	4.2	1.7	2.2	13.1	15.7	1	0	0
32	1/30/98 10:00	6.1	5.6	17.5	213.0	35.7	0.90	0.1067	3.5	1.4	1.9	13.0	15.2	4.60	3.59	12.9	0.8966	13.8	0.6	0.9758	1.5	1.2	0.77	1.0	4.1	3.7	14.8	1.2	1.0	3.7	9.3	14.8	0	0	1
33	5/15/99 21:00	6.5	4.6	19.2	203.0	25.7	0.96	0.1067	3.5	1.4	1.9	13.5	15.6	4.56	3.56	7.4	0.8977	8.0	0.6	0.9758	1.3	0.9	0.66	0.9	3.9	3.7	15.1	3.5	1.4	1.9	13.5	15.6	1	0	0
34	7/30/85 20:00	6.9	4.5	14.4	201.0	23.7	0.97	0.1067	2.6	1.0	1.4	12.1	13.7	4.48	3.50	10.5	0.8954	11.4	0.6	0.9758	1.2	0.6	0.53	0.8	3.9	3.8	15.3	0.6	0.8	3.8	9.1	15.3	0	0	1
35	2/26/03 6:00	5.4	4.6	21.2	210.0	32.7	0.92	0.1067	3.8	1.5	2.1	13.1	15.4	3.82	2.98	8.1	0.9292	9.8	0.6	0.9758	1.4	1.2	0.86	0.9	3.3	3.0	13.0	3.8	1.5	2.1	13.1	15.4	1	0	0
36	7/3/08 21:00	7.1	4.3	13.1	197.0	19.7	0.99	0.1067	2.3	0.9	1.2	11.6	13.1	4.40	3.43	9.9	0.8977	10.9	0.6	0.9758	1.1	0.5	0.46	0.7	3.8	3.8	15.3	0.5	0.7	3.8	9.1	15.3	0	0	1
37	11/29/70 9:00	6.4	6.0	8.1	203.0	25.7	0.96	0.1067	1.7	0.7	0.9	9.8	10.8	4.65	3.63	7.1	0.8985	7.6	0.6	0.9758	1.2	0.7	0.63	1.1	3.9	3.8	15.1	0.7	1.1	3.8	9.3	15.1	0	0	1
38	5/20/75 18:00	5.2	7.9																																

Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, Y <sub>g</sub>	Stockdon					TAW										Results					Methods							
								m <sub>r</sub>	n_bar (ft)	sigma_IG (ft)	sigma_inc (ft)	DWL2% (ft NAVD)	TWL <sub>s</sub> (ft NAVD)	d <sub>100</sub> (ft)	H <sub>100</sub> (ft)	T <sub>m-1.0</sub> (sec)	m <sub>TAW</sub>	Ir <sub>TAW</sub>	Rough. Factor	VWRF	n_bar (ft)	n_bar_red (ft)	n_bar factor	sigma_IG (ft)	sigma_inc (ft)	Revised sigma_inc (ft)	TWL <sub>TAW</sub> (ft NAVD)	n_bar (ft)	sigma_IG (ft)	Revised sigma_inc (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
88	6/5/93 21:00	6.1	4.8	17.5	208.0	30.7	0.94	0.1067	3.2	1.3	1.7	12.5	14.5	4.22	3.29	7.4	0.9239	8.5	0.6	0.9758	1.3	1.0	0.73	0.9	3.6	3.4	14.1	3.2	1.3	1.7	12.5	14.5	1	0	0
89	11/10/08 6:00	5.3	3.9	21.2	205.0	27.7	0.95	0.1067	3.6	1.4	1.9	12.3	14.5	3.33	2.59	8.2	0.9135	10.5	0.6	0.9758	1.2	1.1	0.87	0.8	2.9	2.8	12.1	3.6	1.4	1.9	12.3	14.5	1	0	0
90	5/15/03 20:00	6.2	4.5	17.5	203.0	25.7	0.96	0.1067	3.1	1.3	1.7	12.5	14.4	4.18	3.26	8.3	0.9241	9.6	0.6	0.9758	1.3	0.9	0.70	0.9	3.6	3.5	14.3	0.9	0.9	3.5	8.8	14.3	0	0	1
91	7/26/96 18:00	5.9	5.3	15.9	199.0	21.7	0.98	0.1067	3.1	1.2	1.7	12.0	13.9	4.14	3.23	13.0	0.9248	15.1	0.6	0.9758	1.4	1.1	0.79	0.9	3.7	3.6	14.4	1.1	0.9	3.6	8.8	14.4	0	0	1
92	7/11/98 22:00	6.0	3.3	21.2	205.0	27.7	0.95	0.1067	3.3	1.3	1.8	12.5	14.5	3.52	2.74	9.7	0.9240	12.2	0.6	0.9758	1.1	0.8	0.70	0.7	3.1	2.9	12.8	3.3	1.3	1.8	12.5	14.5	1	0	0
93	7/1/07 21:00	6.0	4.0	19.2	205.0	27.7	0.95	0.1067	3.3	1.3	1.7	12.5	14.5	3.83	2.99	7.7	0.9314	9.4	0.6	0.9758	1.2	0.9	0.73	0.8	3.3	3.1	13.4	3.3	1.3	1.7	12.5	14.5	1	0	0
94	5/20/62 21:00	5.4	4.6	19.2	204.0	26.7	0.96	0.1067	3.5	1.4	1.9	12.3	14.5	3.68	2.87	7.4	0.9247	9.1	0.6	0.9758	1.3	1.1	0.86	0.9	3.2	3.0	12.9	3.5	1.4	1.9	12.3	14.5	1	0	0
95	5/22/63 21:00	6.2	3.8	19.2	203.0	25.7	0.96	0.1067	3.2	1.3	1.7	12.5	14.5	3.88	3.02	10.1	0.9348	12.3	0.6	0.9758	1.1	0.8	0.66	0.8	3.4	3.3	13.7	3.2	1.3	1.7	12.5	14.5	1	0	0
96	2/16/99 9:00	5.5	2.5	25.6	206.0	28.7	0.95	0.1067	3.4	1.4	1.8	12.3	14.5	2.78	2.17	8.6	0.8869	11.7	0.6	0.9758	0.9	0.7	0.78	0.6	2.4	2.3	11.0	3.4	1.4	1.8	12.3	14.5	1	0	0
97	4/22/67 7:00	4.7	5.4	19.2	204.0	26.7	0.96	0.1067	3.8	1.5	2.0	12.1	14.4	3.44	2.68	8.3	0.9145	10.5	0.6	0.9758	1.5	1.5	1.00	1.0	3.0	2.9	12.2	3.8	1.5	2.0	12.1	14.4	1	0	0
98	5/10/83 20:00	5.3	4.6	19.2	205.0	27.7	0.95	0.1067	3.5	1.4	1.9	12.3	14.4	3.63	2.83	7.9	0.9235	9.8	0.6	0.9758	1.3	1.2	0.88	0.9	3.1	3.0	12.7	3.5	1.4	1.9	12.3	14.4	1	0	0
99	10/8/87 9:00	6.5	4.3	14.4	203.0	25.7	0.96	0.1067	2.5	1.0	1.4	11.5	13.1	4.04	3.15	10.8	0.9278	12.8	0.6	0.9758	1.1	0.7	0.61	0.8	3.5	3.4	14.2	0.7	0.8	3.4	8.7	14.2	0	0	1
100	8/2/97 20:00	6.2	3.8	19.2	204.0	26.7	0.96	0.1067	3.2	1.3	1.7	12.5	14.4	3.84	2.99	12.3	0.9344	15.0	0.6	0.9758	1.1	0.8	0.68	0.8	3.4	3.3	13.7	3.2	1.3	1.7	12.5	14.4	1	0	0
101	4/25/63 22:00	6.1	4.9	15.9	197.0	19.7	0.99	0.1067	3.0	1.2	1.6	12.0	13.8	4.15	3.24	7.7	0.9285	8.9	0.6	0.9758	1.3	0.9	0.73	0.9	3.6	3.5	14.3	0.9	0.9	3.5	8.8	14.3	0	0	1
102	9/27/82 17:00	5.4	6.7	14.4	198.0	20.7	0.98	0.1067	3.2	1.3	1.7	11.6	13.6	4.23	3.30	8.2	0.9300	9.5	0.6	0.9758	1.6	1.4	0.89	1.1	3.7	3.6	14.2	1.4	1.1	3.6	8.9	14.2	0	0	1
103	5/13/88 19:00	5.8	4.1	19.2	204.0	26.7	0.96	0.1067	3.3	1.3	1.8	12.3	14.4	3.72	2.90	8.3	0.9281	10.2	0.6	0.9758	1.2	0.9	0.77	0.8	3.2	3.1	13.1	3.3	1.3	1.8	12.3	14.4	1	0	0
104	2/8/94 7:00	6.2	5.5	8.9	213.0	35.7	0.90	0.1067	1.8	0.7	0.9	9.7	10.8	4.17	3.25	7.4	0.9303	8.6	0.6	0.9758	1.1	0.7	0.66	0.9	3.6	3.2	13.7	0.7	0.9	3.2	8.8	13.7	0	0	1
105	5/25/09 21:00	6.6	3.4	19.2	208.0	30.7	0.94	0.1067	3.0	1.2	1.6	12.5	14.4	3.91	3.05	8.0	0.9357	9.7	0.6	0.9758	1.0	0.6	0.56	0.7	3.4	3.2	13.6	3.0	1.2	1.6	12.5	14.4	1	0	0
106	9/16/05 20:00	6.0	4.6	17.5	202.0	24.7	0.97	0.1067	3.2	1.3	1.7	12.3	14.3	4.05	3.16	12.1	0.9305	14.3	0.6	0.9758	1.3	0.9	0.74	0.9	3.6	3.5	14.1	0.9	0.9	3.5	8.7	14.1	0	0	1
107	4/19/08 20:00	5.1	4.8	19.2	203.0	25.7	0.96	0.1067	3.5	1.4	1.9	12.2	14.3	3.53	2.75	10.2	0.9208	12.8	0.6	0.9758	1.3	1.2	0.92	0.9	3.1	3.0	12.6	3.5	1.4	1.9	12.2	14.3	1	0	0
108	3/2/92 8:00	6.2	3.7	19.2	211.0	33.7	0.92	0.1067	3.1	1.3	1.7	12.4	14.3	3.79	2.96	7.7	0.9313	9.4	0.6	0.9758	1.1	0.7	0.66	0.7	3.3	3.0	13.1	3.1	1.3	1.7	12.4	14.3	1	0	0
109	5/26/67 23:00	5.6	4.2	19.2	202.0	24.7	0.97	0.1067	3.3	1.3	1.8	12.2	14.3	3.63	2.83	10.2	0.9259	12.7	0.6	0.9758	1.2	1.0	0.82	0.8	3.2	3.1	13.0	3.3	1.3	1.8	12.2	14.3	1	0	0
110	4/26/94 21:00	6.3	4.4	15.9	204.0	26.7	0.96	0.1067	2.8	1.1	1.5	11.9	13.6	4.06	3.16	8.4	0.9320	9.9	0.6	0.9758	1.2	0.8	0.66	0.8	3.5	3.4	14.0	0.8	0.8	3.4	8.7	14.0	0	0	1
111	7/8/60 21:00	6.8	3.6	14.4	197.0	19.7	0.99	0.1067	2.3	0.9	1.2	11.4	12.8	3.93	3.07	10.8	0.9323	13.1	0.6	0.9758	1.0	0.5	0.48	0.7	3.5	3.4	14.2	0.5	0.7	3.4	8.6	14.2	0	0	1
112	5/5/00 22:00	6.0	3.8	19.2	205.0	27.7	0.95	0.1067	3.2	1.3	1.7	12.3	14.3	3.73	2.91	8.6	0.9296	10.6	0.6	0.9758	1.1	0.8	0.72	0.8	3.2	3.1	13.2	3.2	1.3	1.7	12.3	14.3	1	0	0
113	2/11/92 2:00	5.5	6.4	13.1	217.0	39.7	0.87	0.1067	2.8	1.1	1.5	11.1	12.8	4.12	3.21	10.8	0.9324	12.8	0.6	0.9758	1.5	1.2	0.86	1.0	3.6	3.1	13.4	1.2	1.0	3.1	8.8	13.4	0	0	1
114	1/19/69 9:00	6.8	4.7	6.7	204.0	26.7	0.96	0.1067	1.2	0.5	0.7	9.2	10.0	4.09	3.19	6.5	0.9330	7.7	0.6	0.9758	0.9	0.4	0.43	0.8	3.5	3.3	14.0	0.4	0.8	3.3	8.7	14.0	0	0	1
115	1/10/98 7:00	6.7	4.6	8.1	221.0	43.7	0.83	0.1067	1.5	0.6	0.8	9.6	10.5	4.05	3.16	7.3	0.9331	8.6	0.6	0.9758	1.0	0.5	0.48	0.8	3.5	2.9	13.1	0.5	0.8	2.9	8.7	13.1	0	0	1
116	12/20/02 8:00	6.0	6.2	8.1	210.0	32.7	0.92	0.1067	1.7	0.7	0.9	9.4	10.4	4.15	3.24	8.0	0.9332	9.4	0.6	0.9758	1.2	0.9	0.73	1.0	3.6	3.3	13.7	0.9	1.0	3.3	8.8	13.7	0	0	1
117	4/25/75 21:00	5.8	4.8	17.5	204.0	26.7	0.96	0.1067	3.2	1.3	1.7	12.3	14.3	4.00	3.12	7.7	0.9350	9.2	0.6	0.9758	1.3	1.0	0.79	0.9	3.4	3.3	13.7	3.2	1.3	1.7	12.3	14.3	1	0	0
118	7/18/08 21:00	6.1	3.7	19.2	199.0	21.7	0.98	0.1067	3.1	1.3	1.7	12.3	14.3	3.73	2.91	7.4	0.9289	9.1	0.6	0.9758	1.1	0.8	0.70	0.8	3.2	3.1	13.3	3.1	1.3	1.7	12.3	14.3	1	0	0
119	7/20/01 21:00	6.8	3.3	17.5	206.0	28.7	0.95	0.1067	2.7	1.1	1.4	12.1	13.8	3.94	3.07	9.0	0.9342	10.8	0.6	0.9758	1.0	0.5	0.47	0.7	3.4	3.2	13.9	0.5	0.7	3.2	8.6	13.9	0	0	1
120	5/4/65 0:00	4.7	4.2	21.2	207.0	29.7	0.94	0.1067	3.7	1.5	2.0	12.0	14.2	3.17	2.47	7.0	0.8995	9.0	0.6	0.9758	1.3	1.2	0.99	0.9	2.7	2.6	11.4	3.7	1.5	2.0	12.0	14.2	1	0	0
121	1/6/79 4:00	5.6	5.8	11.9	215.0	37.7	0.89	0.1067	2.4	1.0	1.3	10.4	11.9	4.17	3.25	9.1	0.9355	10.7	0.6	0.9758	1.3	1.1	0.84	1.1	3.6	3.2	13.4	1.1	1.1	3.2	8.8	13.4	0	0	1
122	4/22/03 1:00	4.8	6.0	17.5	203.0	25.7	0.96	0.1067	3.6	1.5	1.9	12.0	14.2	3.73	2.91	8.4	0.9244	10.3	0.6	0.9758	1.5	1.5	0.98	1.0	3.2	3.1	12.9	3.6	1.5	1.9	12.0	14.2	1	0	0
123	5/8/04 23:00	5.6	4.2	19.2	199.0	21.7	0.98	0.1067	3.3	1.3	1.8	12.1	14.2	3.55	2.77	10.2	0.9235	12.8	0.6	0.9758	1.2	1.0	0.82	0.8	3.1	3.1	12.9	3.3	1.3	1.8	12.1	14.2	1	0	0
124	4/16/88 21:00	6.0	5.3	13.1	203.0	25.7	0.96	0.1067	2.6	1.0	1.4	11.1	12.7	4.05	3.16	8.2	0.9367	9.8	0.6	0.9758	1.3	0.9	0.74	0.9	3.5	3.4	13.9	0.9	0.9	3.4	8.7	13.9	0	0	1

Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, $\gamma_B$	TAW														Results					Methods		
								$d_{toe}$ (ft)	$H_{toe}$ (ft)	$T_{m-1.0}$ (sec)	$m_{TAW}$	$I_{rTAW}$	Rough. Factor	VWRF	$n_{bar}$ (ft)	$n_{bar\_red}$ (ft)	$n_{bar}$ factor	$\sigma_{IG}$ (ft)	$\sigma_{inc}$ (ft)	Revised $\sigma_{inc}$ (ft)	$TWL_{TAW}$ (ft NAVD)	$n_{bar}$ (ft)	$\sigma_{IG}$ (ft)	Revised $\sigma_{inc}$ (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
1	3/1/83 23:00	6.0	14.2	11.9	195.0	17.3	0.99	5.22	4.07	11.7	0.6024	7.9	0.6	1.0000	2.6	2.6	1.00	1.8	4.6	4.5	18.3	2.6	1.8	4.5	12.2	18.3	0	0	1
2	1/29/83 9:00	7.3	8.9	11.9	200.0	22.3	0.98	5.05	3.94	10.0	0.6024	6.9	0.6	1.0000	1.9	1.8	0.95	1.4	4.4	4.3	18.1	1.8	1.4	4.3	12.0	18.1	0	0	1
3	1/18/88 8:00	6.8	9.9	11.9	207.0	29.3	0.94	4.74	3.70	10.4	0.6024	7.4	0.6	1.0000	2.1	2.1	1.00	1.4	4.1	3.9	17.1	2.1	1.4	3.9	11.7	17.1	0	0	1
4	5/14/80 21:00	6.8	7.1	17.5	191.0	13.3	1.00	4.17	3.26	9.9	0.6427	8.0	0.6	1.0000	1.9	1.9	1.00	1.2	3.6	3.6	16.3	1.9	1.2	3.6	11.1	16.3	0	0	1
5	2/17/80 10:00	6.6	8.0	14.4	203.0	25.3	0.96	4.15	3.24	11.2	0.6445	9.0	0.6	1.0000	1.9	1.9	1.00	1.3	3.7	3.5	16.0	1.9	1.3	3.5	11.1	16.0	0	0	1
6	2/3/98 3:00	5.7	12.0	11.9	201.0	23.3	0.97	4.27	3.33	9.7	0.6544	7.9	0.6	1.0000	2.3	2.3	1.00	1.6	3.7	3.6	16.0	2.3	1.6	3.6	11.2	16.0	0	0	1
7	6/9/68 20:00	6.6	7.7	14.4	184.0	6.3	1.00	3.95	3.08	10.6	0.6819	9.3	0.6	1.0000	1.8	1.8	1.00	1.2	3.5	3.5	15.8	1.8	1.2	3.5	10.9	15.8	0	0	1
8	2/14/80 7:00	6.9	7.5	11.9	201.0	23.3	0.97	3.84	3.00	8.8	0.7036	8.1	0.6	1.0000	1.7	1.7	1.00	1.1	3.4	3.3	15.4	1.7	1.1	3.3	10.8	15.4	0	0	1
9	1/2/06 10:00	6.5	8.9	8.1	200.0	22.3	0.98	4.02	3.14	7.2	0.7074	6.5	0.6	1.0000	1.6	1.6	1.00	1.4	3.5	3.4	15.4	1.6	1.4	3.4	11.0	15.4	0	0	1
10	8/24/65 19:00	6.8	6.7	14.4	185.0	7.3	1.00	3.75	2.92	12.4	0.7116	11.7	0.6	1.0000	1.6	1.6	1.00	1.1	3.4	3.4	15.5	1.6	1.1	3.4	10.7	15.5	0	0	1
11	11/30/82 8:00	7.9	5.3	6.7	218.0	40.3	0.86	3.75	2.92	6.4	0.7266	6.2	0.6	1.0000	1.1	0.9	0.77	1.0	3.2	2.8	14.6	0.9	1.0	2.8	10.7	14.6	0	0	1
12	2/10/78 0:00	6.1	9.7	8.1	195.0	17.3	0.99	4.02	3.13	7.1	0.7298	6.6	0.6	1.0000	1.7	1.7	1.00	1.6	3.5	3.4	15.3	1.7	1.6	3.4	10.9	15.3	0	0	1
13	12/17/87 6:00	6.2	8.5	11.9	201.0	23.3	0.97	3.77	2.94	10.3	0.7547	10.2	0.6	1.0000	1.8	1.8	1.00	1.4	3.4	3.3	15.1	1.8	1.4	3.3	10.7	15.1	0	0	1
14	2/8/93 10:00	6.7	8.2	8.9	197.0	19.3	0.99	3.66	2.86	8.7	0.7589	8.8	0.6	1.0000	1.7	1.7	1.00	1.1	3.2	3.2	15.1	1.7	1.1	3.2	10.6	15.1	0	0	1
15	1/10/78 9:00	7.0	5.5	15.9	199.0	21.3	0.98	3.58	2.79	9.7	0.7632	10.0	0.6	1.0000	1.5	1.5	0.99	1.0	3.2	3.1	15.0	1.5	1.0	3.1	10.5	15.0	0	0	1
16	1/8/74 8:00	7.3	5.7	9.8	199.0	21.3	0.98	3.57	2.79	7.6	0.7776	8.0	0.6	1.0000	1.3	1.2	0.93	1.0	3.1	3.1	15.0	1.2	1.0	3.1	10.5	15.0	0	0	1
17	11/14/97 8:00	7.3	4.5	17.5	192.0	14.3	1.00	3.43	2.67	10.4	0.7993	11.6	0.6	1.0000	1.4	1.3	0.94	0.9	3.1	3.1	14.9	1.3	0.9	3.1	10.4	14.9	0	0	1
18	2/7/98 6:00	5.8	8.8	14.4	204.0	26.3	0.96	3.60	2.81	11.4	0.8145	12.6	0.6	1.0000	2.0	2.0	1.00	1.4	3.2	3.1	14.6	2.0	1.4	3.1	10.5	14.6	0	0	1
19	3/1/78 2:00	5.8	9.5	8.1	179.0	1.3	1.00	3.78	2.95	7.0	0.8161	7.6	0.6	1.0000	1.7	1.7	1.00	1.6	3.3	3.3	14.8	1.7	1.6	3.3	10.7	14.8	0	0	1
20	8/17/82 20:00	6.9	5.0	15.9	190.0	12.3	1.00	3.31	2.58	14.5	0.8426	17.2	0.6	1.0000	1.4	1.4	1.00	0.9	3.0	3.0	14.7	1.4	0.9	3.0	10.2	14.7	0	0	1
21	7/29/85 19:00	6.8	5.4	15.9	190.0	12.3	1.00	3.35	2.61	11.6	0.8491	13.8	0.6	1.0000	1.5	1.5	1.00	1.0	3.0	3.0	14.7	1.5	1.0	3.0	10.3	14.7	0	0	1
22	8/17/05 19:00	6.6	5.6	15.9	184.0	6.3	1.00	3.27	2.55	14.4	0.8881	18.1	0.6	1.0000	1.5	1.5	1.00	1.0	3.0	3.0	14.5	1.5	1.0	3.0	10.2	14.5	0	0	1
23	1/20/81 9:00	6.9	5.3	14.4	204.0	26.3	0.96	3.23	2.52	12.4	0.8891	15.7	0.6	1.0000	1.4	1.4	1.00	0.9	2.9	2.8	14.2	1.4	0.9	2.8	10.2	14.2	0	0	1
24	7/3/08 21:00	7.1	4.6	14.4	186.0	8.3	1.00	3.14	2.45	10.7	0.8969	13.9	0.6	1.0000	1.3	1.2	0.97	0.9	2.8	2.8	14.3	1.2	0.9	2.8	10.1	14.3	0	0	1
25	6/28/81 18:00	6.4	6.2	15.9	184.0	6.3	1.00	3.21	2.50	14.3	0.8978	18.4	0.6	1.0000	1.6	1.6	1.00	1.1	2.9	2.9	14.3	1.6	1.1	2.9	10.1	14.3	0	0	1
26	6/15/95 23:00	6.0	6.9	17.5	192.0	14.3	1.00	3.28	2.56	11.0	0.8993	14.0	0.6	1.0000	1.8	1.8	1.00	1.2	3.0	3.0	14.2	1.8	1.2	3.0	10.2	14.2	0	0	1
27	6/21/05 20:00	6.6	5.6	14.4	191.0	13.3	1.00	3.14	2.45	11.8	0.9029	15.4	0.6	1.0000	1.5	1.5	1.00	1.0	2.9	2.9	14.1	1.5	1.0	2.9	10.1	14.1	0	0	1
28	9/3/67 20:00	6.4	6.4	14.4	186.0	8.3	1.00	3.13	2.44	13.4	0.9068	17.7	0.6	1.0000	1.6	1.6	1.00	1.1	2.9	2.9	14.1	1.6	1.1	2.9	10.1	14.1	0	0	1
29	1/18/93 6:00	6.4	6.7	11.9	207.0	29.3	0.94	3.17	2.47	8.8	0.9072	11.5	0.6	1.0000	1.6	1.6	1.00	1.1	2.8	2.7	13.8	1.6	1.1	2.7	10.1	13.8	0	0	1
30	6/2/97 19:00	6.6	5.5	14.4	189.0	11.3	1.00	3.08	2.40	10.7	0.9103	14.2	0.6	1.0000	1.4	1.4	1.00	1.0	2.8	2.8	14.0	1.4	1.0	2.8	10.0	14.0	0	0	1
31	6/4/04 22:00	6.6	5.3	15.9	186.0	8.3	1.00	3.07	2.39	12.0	0.9109	15.9	0.6	1.0000	1.5	1.5	1.00	1.0	2.8	2.8	14.0	1.5	1.0	2.8	10.0	14.0	0	0	1
32	7/19/66 22:00	6.5	5.7	14.4	184.0	6.3	1.00	3.05	2.38	11.9	0.9142	15.9	0.6	1.0000	1.5	1.5	1.00	1.0	2.8	2.8	13.9	1.5	1.0	2.8	10.0	13.9	0	0	1
33	11/29/70 9:00	6.4	6.3	8.1	196.0	18.3	0.99	3.14	2.45	7.0	0.9216	9.3	0.6	1.0000	1.3	1.3	1.00	1.2	2.8	2.7	13.7	1.3	1.2	2.7	10.1	13.7	0	0	1
34	1/7/93 8:00	7.1	4.7	8.1	205.0	27.3	0.95	3.02	2.36	6.9	0.9219	9.4	0.6	1.0000	1.1	1.0	0.96	0.9	2.7	2.5	13.5	1.0	0.9	2.5	10.0	13.5	0	0	1
35	2/24/98 7:00	6.1	6.1	17.5	192.0	14.3	1.00	3.07	2.39	9.6	0.9223	12.9	0.6	1.0000	1.6	1.6	1.00	1.1	2.8	2.8	13.7	1.6	1.1	2.8	10.0	13.7	0	0	1
36	5/15/99 21:00	6.5	4.8	19.2	188.0	10.3	1.00	3.02	2.35	8.2	0.9235	11.2	0.6	1.0000	1.4	1.4	1.00	1.0	2.7	2.7	13.7	1.4	1.0	2.7	9.9	13.7	0	0	1
37	5/26/06 20:00	6.7	5.0	14.4	197.0	19.3	0.99	3.02	2.36	7.0	0.9246	9.5	0.6	1.0000	1.3	1.3	1.00	1.0	2.7	2.6	13.6	1.3	1.0	2.6	10.0	13.6	0	0	1
38	2/28/91 9:00	6.0	8.0	8.9	194.0	16.3	0.99	3.11	2.43	8.0	0.9254	10.7	0.6	1.0000	1.6	1.6	1.00	1.2	2.8	2.8	13.7	1.6	1.2	2.8	10.0	13.7	0	0	1
39	8/23/72 20:00	6.2	6.4	14.4	185.0	7.3	1.00	3.00	2.34	11.5	0.9268	15.8	0.6	1.0000	1.6	1.6	1.00	1.1	2.7	2.7	13.7	1.6	1.1	2.7	9.9	13.7	0	0	1
40	11/11/85 7:00	6.6	5.3	13.1	191.0	13.3	1.00	3.01	2.35	7.1	0.9282	9.7	0.6	1.0000	1.4	1.4	1.00	1.0	2.7	2.7	13.6	1.4	1.0	2.7	9.9	13.6	0	0	1
41	12/28/04 9:00	6.3	6.5	8.1	189.0	11.3	1.00	3.06	2.39	7.0	0.9348	9.6	0.6	1.0000	1.3	1.3	1.00	1.2	2.7	2.7	13.5	1.3	1.2	2.7	10.0	13.5	0	0	1
42	1/9/05 8:00	7.4	4.0	6.7	203.0	25.3	0.96	2.88	2.24	6.0	0.9390	8.6	0.6	1.0000	0.9	0.8	0.87	0.8	2.5	2.4	13.3	0.8	0.8	2.4	9.8	13.3	0	0	1
43	6/4/08 21:00	6.9	4.0	15.9	189.0	11.3	1.00	2.80	2.19	9.3	0.9407	13.5	0.6	1.0000	1.2	1.2	1.00	0.8	2.5	2.5	13.4	1.2	0.8	2.5	9.7	13.4	0	0	1
44	3/5/78 6:00	5.8	7.7	13.1	204.0	26.3	0.96	2.97	2.32	10.1	0.9410	14.1	0.6	1.0000	1.7	1.7	1.00	1.2	2.7	2.6	13.2	1.7	1.2	2.6	9.9	13.2	0	0	1
45	12/9/69 8:00	7.0	4.2	13.1	185.0	7.3	1.00	2.77	2.16	9.6	0.9425	14.0	0.6	1.0000	1.2	1.1	0.99	0											

Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, $\gamma_B$	TAW														Results				Methods			
								$d_{toe}$ (ft)	$H_{toe}$ (ft)	$T_{m-1.0}$ (sec)	$m_{TAW}$	$l_{rTAW}$	Rough. Factor	VWRF	$n_{bar}$ (ft)	$n_{bar\_red}$ (ft)	$n_{bar}$ factor	$\sigma_{IG}$ (ft)	$\sigma_{inc}$ (ft)	Revised $\sigma_{inc}$ (ft)	$TWL_{TAW}$ (ft NAVD)	$n_{bar}$ (ft)	$\sigma_{IG}$ (ft)	Revised $\sigma_{inc}$ (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
72	5/15/03 20:00	6.2	4.9	17.5	189.0	11.3	1.00	2.63	2.05	9.5	0.9853	14.8	0.6	1.0000	1.4	1.4	1.00	1.0	2.4	2.4	12.8	1.4	1.0	2.4	9.6	12.8	0	0	1
73	4/25/63 22:00	6.1	5.4	15.9	185.0	7.3	1.00	2.65	2.07	9.1	0.9855	14.2	0.6	1.0000	1.5	1.5	1.00	1.0	2.4	2.4	12.8	1.5	1.0	2.4	9.6	12.8	0	0	1
74	6/21/63 21:00	6.6	3.3	15.9	189.0	11.3	1.00	2.69	2.10	5.7	0.9858	8.8	0.6	1.0000	1.1	1.1	1.00	1.0	2.4	2.4	12.8	1.1	1.0	2.4	9.6	12.8	0	0	1
75	1/19/92 8:00	7.7	2.0	17.5	202.0	24.3	0.97	2.39	1.86	13.0	0.9861	21.3	0.6	1.0000	0.8	0.6	0.72	0.5	2.2	2.1	12.7	0.6	0.5	2.1	9.3	12.7	0	0	1
76	6/10/72 20:00	7.0	3.5	14.4	194.0	16.3	0.99	2.50	1.95	9.4	0.9874	15.1	0.6	1.0000	1.1	1.0	0.99	0.7	2.3	2.3	12.8	1.0	0.7	2.3	9.4	12.8	0	0	1
77	8/25/69 19:00	6.6	3.8	17.5	190.0	12.3	1.00	2.52	1.97	13.2	0.9881	21.1	0.6	1.0000	1.2	1.2	1.00	0.8	2.3	2.3	12.8	1.2	0.8	2.3	9.4	12.8	0	0	1
78	6/21/97 21:00	6.4	4.6	17.5	189.0	11.3	1.00	2.58	2.01	10.8	0.9882	17.1	0.6	1.0000	1.3	1.3	1.00	0.9	2.4	2.4	12.8	1.3	0.9	2.4	9.5	12.8	0	0	1
79	9/16/69 11:00	5.3	7.6	15.9	184.0	6.3	1.00	2.71	2.11	14.7	0.9894	22.6	0.6	1.0000	1.8	1.8	1.00	1.2	2.5	2.5	12.8	1.8	1.2	2.5	9.6	12.8	0	0	1
80	8/6/98 20:00	6.4	5.0	14.4	188.0	10.3	1.00	2.56	1.99	12.6	0.9908	20.0	0.6	1.0000	1.3	1.3	1.00	0.9	2.4	2.4	12.7	1.3	0.9	2.4	9.5	12.7	0	0	1
81	2/21/05 7:00	6.0	6.5	8.1	200.0	22.3	0.98	2.73	2.13	7.2	0.9909	11.0	0.6	1.0000	1.3	1.3	1.00	1.2	2.4	2.4	12.6	1.3	1.2	2.4	9.7	12.6	0	0	1
82	3/20/92 22:00	6.8	5.3	7.4	197.0	19.3	0.99	2.54	1.99	7.7	0.9909	12.2	0.6	1.0000	1.1	1.1	1.00	0.8	2.3	2.3	12.7	1.1	0.8	2.3	9.5	12.7	0	0	1
83	10/27/03 10:00	6.6	3.8	17.5	190.0	12.3	1.00	2.48	1.94	16.0	0.9922	25.8	0.6	1.0000	1.2	1.2	1.00	0.8	2.3	2.3	12.7	1.2	0.8	2.3	9.4	12.7	0	0	1
84	6/30/00 20:00	6.9	3.4	15.9	190.0	12.3	1.00	2.50	1.95	7.9	0.9925	12.6	0.6	1.0000	1.1	1.1	1.00	0.7	2.3	2.2	12.7	1.1	0.7	2.2	9.4	12.7	0	0	1
85	6/6/68 18:00	5.2	7.1	19.2	184.0	6.3	1.00	2.73	2.13	10.1	0.9935	15.5	0.6	1.0000	1.9	1.9	1.00	1.3	2.5	2.5	12.7	1.9	1.3	2.5	9.7	12.7	0	0	1
86	7/21/05 21:00	7.1	2.6	19.2	191.0	13.3	1.00	2.42	1.89	12.0	0.9947	19.7	0.6	1.0000	1.0	0.9	0.94	0.6	2.2	2.2	12.7	0.9	0.6	2.2	9.3	12.7	0	0	1
87	7/18/89 21:00	6.3	4.8	15.9	184.0	6.3	1.00	2.55	1.99	11.1	0.9954	17.7	0.6	1.0000	1.4	1.4	1.00	0.9	2.3	2.3	12.7	1.4	0.9	2.3	9.5	12.7	0	0	1
88	2/7/09 8:00	6.4	4.4	17.5	192.0	14.3	1.00	2.55	1.99	8.5	0.9985	13.7	0.6	1.0000	1.3	1.3	1.00	0.9	2.3	2.3	12.6	1.3	0.9	2.3	9.5	12.6	0	0	1
89	9/4/08 11:00	5.2	6.4	15.9	184.0	6.3	1.00	2.73	2.13	14.9	0.9993	23.1	0.6	1.0000	1.6	1.6	1.00	1.4	2.5	2.5	12.6	1.6	1.4	2.5	9.7	12.6	0	0	1
90	11/11/97 6:00	6.5	3.9	19.2	189.0	11.3	1.00	2.52	1.97	8.5	0.9996	13.7	0.6	1.0000	1.2	1.2	1.00	0.8	2.3	2.3	12.6	1.2	0.8	2.3	9.5	12.6	0	0	1
91	1/10/98 7:00	6.7	4.6	8.1	213.0	35.3	0.90	2.54	1.98	7.1	1.0000	11.4	0.6	1.0000	1.1	1.1	1.00	0.9	2.3	2.1	12.2	1.1	0.9	2.1	9.5	12.2	0	0	1
92	5/11/80 19:00	5.7	5.4	23.3	191.0	13.3	1.00	2.63	2.05	9.1	1.0000	14.4	0.6	1.0000	1.7	1.7	1.00	1.1	2.4	2.4	12.6	1.7	1.1	2.4	9.6	12.6	0	0	1
93	10/3/97 10:00	5.7	5.7	19.2	189.0	11.3	1.00	2.58	2.01	14.6	1.0000	23.4	0.6	1.0000	1.6	1.6	1.00	1.1	2.4	2.4	12.6	1.6	1.1	2.4	9.5	12.6	0	0	1
94	7/27/73 19:00	6.7	3.8	15.9	187.0	9.3	1.00	2.43	1.90	13.7	1.0000	22.6	0.6	1.0000	1.1	1.1	1.00	0.8	2.3	2.3	12.6	1.1	0.8	2.3	9.4	12.6	0	0	1
95	8/8/83 21:00	7.1	2.9	15.9	188.0	10.3	1.00	2.39	1.86	11.0	1.0000	18.2	0.6	1.0000	1.0	0.9	0.96	0.7	2.2	2.2	12.6	0.9	0.7	2.2	9.3	12.6	0	0	1
96	12/20/64 9:00	6.8	3.3	14.4	186.0	8.3	1.00	2.52	1.97	6.7	1.0000	10.7	0.6	1.0000	1.0	1.0	1.00	0.8	2.2	2.2	12.6	1.0	0.8	2.2	9.5	12.6	0	0	1
97	6/3/85 21:00	7.1	2.9	15.9	194.0	16.3	0.99	2.40	1.87	7.1	1.0000	11.8	0.6	1.0000	1.0	0.9	0.95	0.7	2.2	2.1	12.5	0.9	0.7	2.1	9.3	12.5	0	0	1
98	6/21/09 20:00	6.9	3.6	13.1	192.0	14.3	1.00	2.43	1.89	7.1	1.0000	11.7	0.6	1.0000	1.0	1.0	1.00	0.7	2.2	2.2	12.5	1.0	0.7	2.2	9.4	12.5	0	0	1
99	6/30/96 20:00	6.6	3.6	17.5	189.0	11.3	1.00	2.41	1.88	13.7	1.0000	22.6	0.6	1.0000	1.2	1.2	1.00	0.8	2.2	2.2	12.5	1.2	0.8	2.2	9.3	12.5	0	0	1
100	8/2/97 20:00	6.2	4.5	19.2	190.0	12.3	1.00	2.48	1.93	13.5	1.0000	21.9	0.6	1.0000	1.4	1.4	1.00	0.9	2.3	2.3	12.5	1.4	0.9	2.3	9.4	12.5	0	0	1
101	4/25/71 21:00	6.3	4.9	15.9	187.0	9.3	1.00	2.51	1.96	7.7	1.0000	12.4	0.6	1.0000	1.4	1.4	1.00	0.9	2.3	2.3	12.5	1.4	0.9	2.3	9.4	12.5	0	0	1
102	6/2/81 21:00	7.0	2.9	17.5	189.0	11.3	1.00	2.39	1.87	7.4	1.0000	12.3	0.6	1.0000	1.0	1.0	0.99	0.7	2.2	2.2	12.5	1.0	0.7	2.2	9.3	12.5	0	0	1
103	9/20/69 16:00	5.3	7.3	15.9	184.0	6.3	1.00	2.60	2.02	12.7	1.0000	20.2	0.6	1.0000	1.8	1.8	1.00	1.2	2.4	2.4	12.5	1.8	1.2	2.4	9.5	12.5	0	0	1
104	12/15/93 10:00	6.1	4.5	21.2	193.0	15.3	1.00	2.52	1.97	7.9	1.0000	12.8	0.6	1.0000	1.4	1.4	1.00	1.0	2.3	2.3	12.4	1.4	1.0	2.3	9.5	12.4	0	0	1
105	6/6/05 20:00	5.8	5.9	15.9	185.0	7.3	1.00	2.56	1.99	9.1	0.9997	14.7	0.6	1.0000	1.6	1.6	1.00	1.1	2.3	2.3	12.5	1.6	1.1	2.3	9.5	12.5	0	0	1
106	6/5/93 21:00	6.1	4.9	17.5	195.0	17.3	0.99	2.51	1.96	7.9	0.9989	12.7	0.6	1.0000	1.4	1.4	1.00	1.0	2.3	2.2	12.4	1.4	1.0	2.2	9.4	12.4	0	0	1
107	12/30/82 8:00	7.4	2.3	15.9	195.0	17.3	0.99	2.31	1.80	8.1	0.9987	13.7	0.6	1.0000	0.8	0.7	0.83	0.6	2.1	2.1	12.4	0.7	0.6	2.1	9.2	12.4	0	0	1
108	7/10/87 20:00	7.2	2.5	17.5	192.0	14.3	1.00	2.29	1.79	13.8	0.9980	23.3	0.6	1.0000	0.9	0.8	0.92	0.6	2.1	2.1	12.4	0.8	0.6	2.1	9.2	12.4	0	0	1
109	6/8/64 20:00	6.4	4.4	14.4	187.0	9.3	1.00	2.49	1.95	6.7	0.9980	10.8	0.6	1.0000	1.2	1.2	1.00	0.9	2.2	2.2	12.4	1.2	0.9	2.2	9.4	12.4	0	0	1
110	9/27/82 17:00	5.4	7.2	15.9	185.0	7.3	1.00	2.60	2.03	9.2	0.9973	14.6	0.6	1.0000	1.8	1.8	1.00	1.2	2.4	2.4	12.4	1.8	1.2	2.4	9.5	12.4	0	0	1
111	5/4/04 21:00	6.3	4.9	14.4	184.0	6.3	1.00	2.43	1.89	12.7	0.9949	20.8	0.6	1.0000	1.3	1.3	1.00	0.9	2.2	2.2	12.4	1.3	0.9	2.2	9.4	12.4	0	0	1
112	6/24/91 19:00	5.4	6.9	15.9	184.0	6.3	1.00	2.55	1.99	12.5	0.9945	19.9	0.6	1.0000	1.7	1.7	1.00	1.2	2.4	2.4	12.4	1.7	1.2	2.4	9.5	12.4	0	0	1
113	7/9/83 20:00	7.2	3.0	11.9	186.0	8.3	1.00	2.32	1.81	7.8	0.9934	13.1	0.6	1.0000	0.9	0.8	0.91	0.6	2.1	2.1	12.4	0.8	0.6	2.1	9.2	12.4	0	0	1
114	6/18/85 21:00	6.4	4.3	15.9	190.0	12.3	1.00	2.41	1.88	10.5	0.9930	17.2	0.6	1.0000	1.2	1.2	1.00	0.8	2.2	2.2	12.4	1.2	0.8	2.2	9.3	12.4	0	0	1
115	7/20/86 20:00	7.1	2.7	15.9	198.0	20.3	0.98	2.31	1.80	8.6	0.9928	14.5	0.6	1.0000	0.9	0.9	0.94	0.6	2.1	2.1	12.3	0.9	0.6	2.1	9.2	12.3	0	0	1
116	5/21/08 21:00	5.9	5.9	14.4	186.0	8.3	1.00	2.52	1.96	8.3	0.9926	13.2	0.6	1.0000	1.														

Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, Y <sub>6</sub>	DIM							TAW										Results				Methods							
								Gamma	m_dim	n_bar (ft)	sigma_JG (ft)	sigma_inc (ft)	DWL2% <sub>DIM</sub> (ft NAVD)	TWL <sub>DIM</sub> (ft NAVD)	d <sub>100</sub> (ft)	H <sub>100</sub> (ft)	T <sub>m-10</sub> (sec)	m <sub>TAW</sub>	l <sub>rTAW</sub>	Rough. Factor	VWRF	n_bar (ft)	n_bar_red (ft)	n_bar factor	sigma_JG (ft)	sigma_inc (ft)	Revised sigma_inc (ft)	TWL <sub>TAW</sub> (ft NAVD)	n_bar (ft)	sigma_JG (ft)	Revised sigma_inc (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
1	3/1/83 23:00	6.0	14.2	11.9	195.0	17.3	0.99	1.0	0.0394	2.6	1.8	1.2	12.9	1.90	1.48	11.7	1.0000	21.7	1.0	1.0000	2.6	2.6	1.00	1.8	2.9	2.9	15.4	2.6	1.8	2.9	12.1	15.4	0	0	1	
2	1/29/83 9:00	7.3	8.9	11.9	200.0	22.3	0.98	1.9	0.0521	1.9	1.4	1.3	12.0	1.81	1.41	10.0	1.0000	19.1	1.0	1.0000	1.9	1.9	1.00	1.4	2.8	2.7	15.3	1.9	1.4	2.7	12.0	15.3	0	0	1	
3	1/18/88 8:00	6.8	9.9	11.9	207.0	29.3	0.94	1.0	0.0488	2.1	1.4	1.2	11.7	1.42	1.10	10.4	1.0000	22.5	1.0	1.0000	2.1	2.1	1.00	1.4	2.2	2.1	13.9	2.1	1.4	2.1	11.7	13.9	0	0	1	
4	5/14/80 21:00	6.8	7.1	17.5	191.0	13.3	1.00	1.0	0.0506	1.8	1.2	1.6	11.1	1.27	0.85	0.66	9.9	1.0000	27.5	1.0	1.0000	1.8	1.8	1.00	1.2	1.3	1.3	12.2	1.8	1.2	1.6	11.1	12.2	0	1	0
5	2/3/98 3:00	5.7	12.0	11.9	201.0	23.3	0.97	1.0	0.0431	2.3	1.6	1.2	11.2	0.95	0.74	9.7	1.0000	25.5	1.0	1.0000	2.3	2.3	1.00	1.6	1.5	1.4	12.3	2.3	1.6	1.4	11.2	12.3	0	0	1	
6	2/17/80 10:00	6.6	8.0	14.4	203.0	25.3	0.96	1.0	0.0505	1.9	1.3	1.4	11.1	0.83	0.65	11.2	1.0000	31.4	1.0	1.0000	1.9	1.9	1.00	1.3	1.3	1.3	12.1	1.9	1.3	1.4	11.1	12.3	0	1	0	
7	11/14/97 8:00	7.3	4.5	17.5	192.0	14.3	1.00	1.0	0.0630	1.3	0.9	1.6	10.4	0.18	0.14	10.4	1.0000	62.9	1.0	1.0000	1.3	1.3	1.00	0.9	0.3	0.3	10.5	1.3	0.9	1.6	10.4	12.3	0	1	0	
8	6/8/68 19:00	6.3	8.0	15.9	184.0	6.3	1.00	1.0	0.0482	1.9	1.3	1.5	10.8	0.56	0.44	12.2	1.0000	41.8	1.0	1.0000	1.9	1.9	1.00	1.3	0.9	0.9	11.3	1.9	1.3	1.5	10.8	12.1	0	1	0	
9	1/10/78 9:00	7.0	5.5	15.9	199.0	21.3	0.98	1.0	0.0584	1.5	1.0	1.5	10.5	0.27	0.21	9.7	1.0000	47.4	1.0	1.0000	1.5	1.5	1.00	1.0	0.4	0.4	10.7	1.5	1.0	1.5	10.5	12.1	0	1	0	
10	8/16/82 19:00	6.9	4.9	17.5	190.0	12.3	1.00	1.0	0.0595	1.4	1.0	1.6	10.2			15.6																				
11	6/13/95 21:00	6.7	3.8	21.2	191.0	13.3	1.00	1.0	0.0630	1.3	0.9	1.8	9.7			15.8																				
12	8/24/65 19:00	6.8	6.7	14.4	185.0	7.3	1.00	1.0	0.0510	1.6	1.1	1.3	10.7	0.42	0.33	12.4	1.0000	48.9	1.0	1.0000	1.6	1.6	1.00	1.1	0.7	0.7	11.0	1.6	1.1	1.3	10.7	11.9	0	1	0	
13	7/21/05 21:00	7.1	2.6	19.2	191.0	13.3	1.00	1.0	0.0824	1.0	0.6	1.7	9.4			12.0																				
14	5/15/99 21:00	6.5	4.8	19.2	188.0	10.3	1.00	1.0	0.0574	1.4	1.0	1.6	9.9			8.2																				
15	7/29/85 19:00	6.8	5.4	15.9	190.0	12.3	1.00	1.0	0.0578	1.5	1.0	1.5	10.3	0.02	0.02	11.6	1.0000	196.7	1.0	1.0000	1.5	1.5	1.00	1.0	0.0	0.0	10.3	1.5	1.0	1.5	10.3	11.8	0	1	0	
16	11/30/82 8:00	7.9	5.3	6.7	218.0	40.3	0.86	5.2	0.0838	1.1	1.0	0.9	10.9	0.66	0.51	6.4	1.0000	20.2	1.0	1.0000	1.1	1.1	1.00	1.0	1.0	0.9	10.9	1.1	1.0	0.9	10.9	11.6	0	0	1	
17	6/30/73 20:00	6.7	3.5	21.2	186.0	8.3	1.00	1.0	0.0650	1.2	0.8	1.8	9.5			13.2																				
18	8/17/05 19:00	6.6	5.6	15.9	184.0	6.3	1.00	1.0	0.0581	1.5	1.0	1.5	10.2			14.4																				
19	2/14/80 7:00	6.9	7.5	11.9	201.0	23.3	0.97	1.0	0.0512	1.7	1.1	1.1	10.8	0.52	0.40	8.8	1.0000	31.2	1.0	1.0000	1.7	1.7	1.00	1.1	0.8	0.8	11.3	1.7	1.1	1.1	10.8	11.7	0	1	0	
20	2/7/98 6:00	5.8	8.8	14.4	204.0	26.3	0.96	1.0	0.0473	2.0	1.4	1.4	10.5	0.28	0.22	11.4	1.0000	55.6	1.0	1.0000	2.0	2.0	1.00	1.4	0.4	0.4	10.6	2.0	1.4	1.4	10.5	11.7	0	1	0	
21	1/2/06 10:00	6.5	8.9	8.1	200.0	22.3	0.98	4.9	0.0515	1.6	1.4	0.8	10.9	0.70	0.54	7.2	1.0000	22.2	1.0	1.0000	1.6	1.6	1.00	1.4	1.1	1.1	11.6	1.6	1.4	1.1	10.9	11.6	0	0	1	
22	6/20/05 19:00	6.3	5.9	15.9	190.0	12.3	1.00	1.0	0.0595	1.6	1.1	1.6	10.0			13.4																				
23	4/25/98 20:00	6.0	5.0	23.3	192.0	14.3	1.00	1.0	0.0494	1.6	1.1	1.8	9.7			8.0																				
24	1/19/92 8:00	7.7	2.0	17.5	202.0	24.3	0.97	1.0	0.1083	0.8	0.5	1.5	9.5			13.0																				
25	6/3/08 20:00	7.0	3.6	17.5	189.0	11.3	1.00	1.0	0.0689	1.2	0.8	1.6	9.7			8.5																				
26	12/30/82 8:00	7.4	2.3	15.9	195.0	17.3	0.99	1.0	0.0966	0.8	0.6	1.6	9.4			8.1																				
27	5/11/80 19:00	5.7	5.4	23.3	191.0	13.3	1.00	1.0	0.0496	1.7	1.1	1.8	9.6			9.1																				
28	2/10/78 0:00	6.1	9.7	8.1	195.0	17.3	0.99	5.9	0.0505	1.7	1.6	0.9	10.9	0.69	0.54	7.1	1.0000	21.8	1.0	1.0000	1.7	1.7	1.00	1.6	1.1	1.1	11.6	1.7	1.6	1.1	10.9	11.6	0	0	1	
29	7/3/08 21:00	7.1	4.6	14.4	186.0	8.3	1.00	1.0	0.0644	1.3	0.9	1.4	10.1			10.7																				
30	12/17/87 6:00	6.2	8.5	11.9	201.0	23.3	0.97	1.8	0.0500	1.8	1.4	1.2	10.7	0.44	0.35	10.3	1.0000	39.6	1.0	1.0000	1.8	1.8	1.00	1.4	0.7	0.7	11.0	1.8	1.4	1.2	10.7	11.6	0	1	0	
31	7/10/87 20:00	7.2	2.5	17.5	192.0	14.3	1.00	1.0	0.0872	0.9	0.6	1.6	9.3			13.8																				
32	1/20/81 9:00	6.9	5.3	14.4	204.0	26.3	0.96	1.0	0.0598	1.4	0.9	1.3	10.1			12.4																				
33	7/23/09 22:00	6.5	4.4	19.2	188.0	10.3	1.00	1.0	0.0589	1.4	0.9	1.6	9.6			13.7																				
34	5/25/67 22:00	6.3	3.4	23.3	189.0	11.3	1.00	1.0	0.0622	1.2	0.8	1.8	9.1			11.3																				
35	4/25/94 21:00	6.2	5.3	17.5	191.0	13.3	1.00	1.0	0.0580	1.5	1.0	1.6	9.8			7.3																				
36	6/4/04 22:00	6.6	5.3	15.9	186.0	8.3	1.00	1.0	0.0574	1.4	1.0	1.4	10.0			12.0																				
37	6/15/65 21:00	5.7	5.0	21.2	190.0	12.3	1.00	1.0	0.0584	1.5	1.0	1.9	9.3			8.5																				
38	1/8/74 8:00	7.3	5.7	9.8	199.0	21.3	0.98	2.2	0.0658	1.3	1.0	1.0	10.6	0.34	0.26	7.6	1.0000	33.3	1.0	1.0000	1.3	1.3	1.00	1.0	0.5	0.5	10.8	1.3	1.0	1.0	10.6	11.5	0	1	0	
39	12/15/93 10:00	6.1	4.5	21.2	193.0	15.3	1.00	1.0	0.0562	1.4	1.0	1.7	9.4			7.9																				
40	6/2/81 21:00	7.0	2.9	17.5	189.0	11.3	1.00	1.0	0.0791	1.0	0.7	1.6	9.3			7.4																				
41	10/26/03 9:00	6.7	3.4	19.2	189.0	11.3	1.00	1.0	0.0680	1.1	0.8	1.6	9.4			17.2																				
42	4/18/92 22:00	6.5	3.2	21.2	191.0	13.3	1.00	1.0	0.0670	1.1	0.8	1.7	9.2			7.6																				
43	2/24/98 7:00	6.1	6.1	17.5	192.0	14.3	1.00	1.0	0.0499	1.6	1.1	1.5	10.0			9.6																				
44	6/1/97 19:00	6.2	5.8	15.9	189.0	11.3	1.00	1.0	0.0587	1.5	1.0	1.5	9.8			10.6																				
45	2/8/93 10:00	6.7	8.2	8.9	197.0	19.3	0.99	1.0	0.0610	1.6	1.1	1.1	10.6	0.34	0.26	8.7	1.0000	38.4	1.0	1.0000	1.6	1.6	1.00	1.1</												



Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, $\gamma_b$	Stockdon					TAW										Results					Methods							
								$m_i$	n_bar (ft)	sigma_IG (ft)	sigma_inc (ft)	DWL2% (ft NAVD)	TWL <sub>5</sub> (ft NAVD)	$d_{DB}$ (ft)	$H_{DB}$ (ft)	$T_{m-1.0}$ (sec)	$m_{TAW}$	$I_{TAW}$	Rough. Factor	VWRF	n_bar (ft)	n_bar_red (ft)	n_bar factor	sigma_IG (ft)	sigma_inc (ft)	Revised sigma_inc (ft)	TWL <sub>TAW</sub> (ft NAVD)	n_bar (ft)	sigma_IG (ft)	Revised sigma_inc (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
1	3/1/83 23:00	6.0	8.7	19.2	192.0	67.1	0.63	0.1003	4.5	1.9	2.4	15.2	17.9	4.01	3.13	12.0	0.6390	9.8	1.0	1.0000	2.0	2.0	1.00	1.3	5.9	3.7	15.9	2.0	1.3	3.7	10.6	15.9	0	0	1
2	1/29/83 9:00	7.3	4.9	11.9	193.0	68.1	0.63	0.1003	2.1	0.9	1.1	11.5	12.8	3.31	2.58	9.8	0.6390	8.8	1.0	1.0000	1.1	0.9	0.85	0.8	4.9	3.1	14.6	0.9	0.8	3.1	9.9	14.6	0	0	1
3	1/18/88 8:00	6.8	4.9	15.9	192.0	67.1	0.63	0.1003	2.8	1.2	1.5	12.5	14.2	3.07	2.39	10.8	0.6390	10.1	1.0	1.0000	1.2	1.2	0.95	0.8	4.5	2.9	14.0	1.2	0.8	2.9	9.6	14.0	0	0	1
4	5/14/80 21:00	6.8	4.5	17.5	186.0	61.1	0.63	0.1003	2.9	1.3	1.6	12.8	14.5	2.92	2.27	11.3	0.6390	10.8	1.0	1.0000	1.2	1.1	0.97	0.8	4.3	2.7	13.6	1.1	0.8	2.7	9.5	13.6	0	0	1
5	3/1/78 2:00	5.8	8.2	8.1	173.0	48.1	0.79	0.1003	1.8	0.8	1.0	9.6	10.7	3.16	2.46	7.2	0.6390	6.6	1.0	1.0000	1.4	1.4	1.00	1.3	4.5	3.6	14.8	1.4	1.3	3.6	9.7	14.8	0	0	1
6	8/24/65 19:00	6.8	4.6	14.4	180.0	55.1	0.71	0.1003	2.5	1.0	1.3	11.8	13.3	2.83	2.21	12.6	0.6390	12.3	1.0	1.0000	1.1	1.1	0.95	0.8	4.2	3.0	14.1	1.1	0.8	3.0	9.4	14.1	0	0	1
7	6/9/68 20:00	6.6	5.0	14.4	180.0	55.1	0.71	0.1003	2.6	1.1	1.4	11.8	13.4	2.82	2.20	11.1	0.6396	10.9	1.0	1.0000	1.2	1.2	1.00	0.8	4.2	3.0	13.9	1.2	0.8	3.0	9.4	13.9	0	0	1
8	2/3/98 3:00	5.7	8.7	9.8	183.0	58.1	0.67	0.1003	2.3	1.0	1.2	10.4	11.8	2.94	2.29	9.2	0.6425	8.8	1.0	1.0000	1.6	1.6	1.00	1.1	4.3	2.9	13.5	1.6	1.1	2.9	9.5	13.5	0	0	1
9	8/16/82 19:00	6.9	3.7	17.5	182.0	57.1	0.68	0.1003	2.7	1.1	1.4	12.3	13.9	2.65	2.07	16.3	0.6454	16.6	1.0	1.0000	1.0	1.0	0.93	0.7	4.0	2.8	13.5	1.0	0.7	2.8	9.2	13.5	0	0	1
10	1/2/06 10:00	6.5	5.7	8.1	190.0	65.1	0.63	0.1003	1.5	0.7	0.8	9.6	10.5	2.83	2.21	6.9	0.6491	6.8	1.0	1.0000	1.1	1.1	1.00	1.0	4.1	2.6	13.0	1.1	1.0	2.6	9.4	13.0	0	0	1
11	2/14/80 7:00	6.9	5.0	9.8	186.0	61.1	0.63	0.1003	1.7	0.7	0.9	10.4	11.5	2.66	2.07	8.4	0.6520	8.6	1.0	1.0000	1.0	1.0	0.94	0.7	3.9	2.4	12.9	1.0	0.7	2.4	9.2	12.9	0	0	1
12	7/2/08 20:00	7.2	2.8	19.2	187.0	62.1	0.61	0.1003	2.5	1.1	1.4	12.4	13.9	2.53	1.98	12.4	0.6543	13.0	1.0	1.0000	0.9	0.7	0.82	0.6	3.8	2.3	12.8	0.7	0.6	2.3	9.1	12.8	0	0	1
13	3/20/92 22:00	6.8	3.7	19.2	184.0	59.1	0.66	0.1003	2.9	1.3	1.6	12.8	14.5	2.64	2.06	7.6	0.6559	7.9	1.0	1.0000	1.1	1.0	0.96	0.7	3.8	2.5	13.0	1.0	0.7	2.5	9.2	13.0	0	0	1
14	11/14/97 8:00	7.3	2.8	17.5	185.0	60.1	0.64	0.1003	2.3	1.0	1.2	12.0	13.4	2.50	1.95	11.5	0.6576	12.2	1.0	1.0000	0.8	0.7	0.81	0.6	3.7	2.4	12.9	0.7	0.6	2.4	9.1	12.9	0	0	1
15	8/17/05 19:00	6.6	4.0	15.9	179.0	54.1	0.72	0.1003	2.5	1.1	1.3	11.8	13.3	2.48	1.93	14.5	0.6630	15.7	1.0	1.0000	1.0	1.0	0.99	0.7	3.8	2.7	13.2	1.0	0.7	2.7	9.1	13.2	0	0	1
16	2/9/78 23:00	6.3	5.8	7.4	188.0	63.1	0.63	0.1003	1.4	0.6	0.8	9.2	10.0	2.66	2.08	6.7	0.6650	7.0	1.0	1.0000	1.0	1.0	1.00	1.0	3.8	2.4	12.5	1.0	1.0	2.4	9.2	12.5	0	0	1
17	1/8/74 8:00	7.3	3.4	8.9	188.0	63.1	0.63	0.1003	1.3	0.6	0.7	10.0	10.8	2.49	1.94	7.4	0.6651	8.0	1.0	1.0000	0.8	0.6	0.78	0.6	3.6	2.3	12.6	0.6	0.6	2.3	9.1	12.6	0	0	1
18	2/8/93 10:00	6.7	5.2	8.9	187.0	62.1	0.61	0.1003	1.6	0.7	0.9	10.0	11.0	2.52	1.97	8.3	0.6652	8.9	1.0	1.0000	1.0	1.0	0.97	0.7	3.7	2.3	12.5	1.0	0.7	2.3	9.1	12.5	0	0	1
19	6/14/95 22:00	6.4	3.9	19.2	185.0	60.1	0.64	0.1003	3.0	1.3	1.6	12.6	14.4	2.43	1.90	16.4	0.6684	18.0	1.0	1.0000	1.1	1.1	1.00	0.7	3.7	2.4	12.5	1.1	0.7	2.4	9.0	12.5	0	0	1
20	7/29/85 19:00	6.8	3.5	15.9	185.0	60.1	0.64	0.1003	2.4	1.0	1.3	11.6	13.1	2.42	1.89	12.1	0.6689	13.4	1.0	1.0000	1.0	0.9	0.95	0.6	3.6	2.3	12.6	0.9	0.6	2.3	9.0	12.6	0	0	1
21	5/11/80 19:00	5.7	3.6	23.3	183.0	58.1	0.67	0.1003	3.5	1.5	1.9	12.9	15.0	1.69	1.32	11.9	0.7877	18.5	1.0	1.0000	1.1	1.1	1.00	0.7	2.6	1.7	10.5	3.5	1.5	1.9	12.9	15.0	1	0	0
22	6/28/81 18:00	6.4	4.3	15.9	179.0	54.1	0.72	0.1003	2.6	1.1	1.4	11.7	13.3	2.40	1.87	14.4	0.6733	16.1	1.0	1.0000	1.1	1.1	1.00	0.7	3.7	2.6	13.0	1.1	0.7	2.6	9.0	13.0	0	0	1
23	11/30/82 8:00	7.9	2.2	6.1	205.0	80.1	0.63	0.1003	0.7	0.3	0.4	9.3	9.8	2.36	1.84	6.4	0.6745	7.2	1.0	1.0000	0.5	0.2	0.34	0.4	3.4	2.1	12.4	0.2	0.4	2.1	8.9	12.4	0	0	1
24	6/3/04 21:00	6.8	3.3	17.5	181.0	56.1	0.69	0.1003	2.5	1.1	1.3	11.9	13.4	2.34	1.82	14.7	0.6753	16.6	1.0	1.0000	0.9	0.9	0.96	0.6	3.6	2.5	12.8	0.9	0.6	2.5	8.9	12.8	0	0	1
25	1/10/78 9:00	7.0	3.1	15.9	190.0	65.1	0.63	0.1003	2.2	0.9	1.2	11.5	12.8	2.36	1.84	9.3	0.6753	10.5	1.0	1.0000	0.9	0.8	0.88	0.6	3.5	2.2	12.3	0.8	0.6	2.2	8.9	12.3	0	0	1
26	6/30/73 21:00	6.8	2.8	21.2	178.0	53.1	0.73	0.1003	2.8	1.2	1.5	12.6	14.3	2.31	1.80	14.6	0.6770	16.7	1.0	1.0000	0.9	0.8	0.93	0.6	3.5	2.5	13.0	0.8	0.6	2.5	8.9	13.0	0	0	1
27	4/25/98 20:00	6.0	3.2	23.3	184.0	59.1	0.66	0.1003	3.3	1.4	1.8	12.7	14.7	1.77	1.38	10.0	0.7916	15.2	1.0	1.0000	1.0	1.0	1.00	0.7	2.7	1.8	10.8	3.3	1.4	1.8	12.7	14.7	1	0	0
28	2/17/80 10:00	6.6	3.9	13.1	195.0	70.1	0.63	0.1003	2.1	0.9	1.1	10.8	12.1	2.29	1.79	10.8	0.6853	12.5	1.0	1.0000	1.0	0.9	0.98	0.6	3.4	2.2	12.1	0.9	0.6	2.2	8.9	12.1	0	0	1
29	9/3/67 20:00	6.4	4.4	14.4	181.0	56.1	0.69	0.1003	2.4	1.0	1.3	11.2	12.7	2.30	1.79	13.6	0.6870	15.7	1.0	1.0000	1.1	1.1	1.00	0.7	3.5	2.4	12.5	1.1	0.7	2.4	8.9	12.5	0	0	1
30	12/28/04 9:00	6.3	5.0	8.1	180.0	55.1	0.71	0.1003	1.4	0.6	0.8	9.2	10.1	2.44	1.90	6.9	0.6876	7.7	1.0	1.0000	1.0	1.0	1.00	0.9	3.5	2.5	12.6	1.0	0.9	2.5	9.0	12.6	0	0	1
31	11/29/70 9:00	6.4	4.4	8.1	186.0	61.1	0.63	0.1003	1.4	0.6	0.7	9.2	10.0	2.39	1.87	6.7	0.6918	7.7	1.0	1.0000	0.9	0.9	1.00	0.8	3.5	2.2	12.0	0.9	0.8	2.2	9.0	12.0	0	0	1
32	6/15/65 21:00	5.7	3.2	23.3	183.0	58.1	0.67	0.1003	3.3	1.4	1.8	12.5	14.5	1.47	1.14	11.2	0.7770	18.5	1.0	1.0000	1.0	1.0	1.00	0.7	2.2	1.5	10.0	3.3	1.4	1.8	12.5	14.5	1	0	0
33	7/19/66 22:00	6.5	3.9	14.4	180.0	55.1	0.71	0.1003	2.3	1.0	1.2	11.1	12.5	2.25	1.76	12.2	0.6933	14.4	1.0	1.0000	1.0	1.0	1.00	0.7	3.4	2.4	12.5	1.0	0.7	2.4	8.8	12.5	0	0	1
34	6/21/05 20:00	6.6	3.6	14.4	186.0	61.1	0.63	0.1003	2.2	0.9	1.2	11.1	12.4	2.22	1.73	12.2	0.6965	14.6	1.0	1.0000	0.9	0.9	0.99	0.6	3.4	2.1	12.0	0.9	0.6	2.1	8.8	12.0	0	0	1
35	6/2/97 19:00	6.6	3.5	14.4	185.0	60.1	0.64	0.1003	2.2	0.9	1.2	11.0	12.3	2.20	1.71	11.8	0.7018	14.4	1.0	1.0000	0.9	0.9	0.99	0.6	3.3	2.1	12.0	0.9	0.6	2.1	8.8	12.0	0	0	1
36	10/26/03 9:00	6.7	2.8	19.2	183.0	58.1	0.67	0.1003	2.6	1.1	1.4	11.9	13.5	2.14	1.67	18.1	0.7047	22.3	1.0	1.0000	0.9	0.8	0.97	0.6	3.3	2.2	12.1	0.8	0.6	2.2	8.7	12.1	0	0	1
37	7/30/08 19:00	7.0	2.4	19.2	191.0	66.1	0.63	0.1003	2.4	1.0	1.3	11.8	13.2	2.13	1.66	14.1	0.7056	17.5	1.0	1.0000	0.8	0.7	0.88	0.5	3.2	2.0	11.9	0.7	0.5	2.0	8.7	11.9	0	0	1
38	1/9/05 8:00	7.4	2.5</																																

Peak	Date/Time	SWL (ft NAVD)	Ho (ft)	Tp (sec)	Dp (deg N @15m depth)	Wave Angle with Normally Incident Waves (deg)	Wave Direction Factor, Y <sub>B</sub>	Stockdon					TAW										Results					Methods							
								m <sub>r</sub>	n_bar (ft)	sigma_IG (ft)	sigma_inc (ft)	DWL2% (ft NAVD)	TWL <sub>5</sub> (ft NAVD)	d <sub>DB</sub> (ft)	H <sub>DB</sub> (ft)	T <sub>m-1.0</sub> (sec)	m <sub>TAW</sub>	l <sub>TAW</sub>	Rough. Factor	VWRF	n_bar (ft)	n_bar_red (ft)	n_bar factor	sigma_IG (ft)	sigma_inc (ft)	Revised sigma_inc (ft)	TWL <sub>TAW</sub> (ft NAVD)	n_bar (ft)	sigma_IG (ft)	Revised sigma_inc (ft)	DWL2% (ft NAVD)	TWL (ft NAVD)	Stockdon	DIM	TAW
88	4/9/97 23:00	5.5	3.7	19.2	179.0	54.1	0.72	0.1003	2.9	1.3	1.6	11.5	13.3	1.38	1.08	8.0	0.7698	13.5	1.0	1.0000	0.7	2.1	1.5	9.9	2.9	1.3	1.6	11.5	13.3	1	0	0			
89	7/20/01 21:00	6.8	2.3	17.5	188.0	63.1	0.63	0.1003	2.1	0.9	1.1	11.1	12.3	1.87	1.46	11.4	0.7819	16.7	1.0	1.0000	0.7	0.7	0.93	0.5	2.9	1.8	11.2	0.7	0.5	1.8	8.5	11.2	0	0	1
90	6/11/98 22:00	5.6	2.9	21.2	185.0	60.1	0.64	0.1003	2.9	1.2	1.5	11.5	13.3	1.20	0.94	13.6	0.7603	24.1	1.0	1.0000	0.9	0.9	1.00	0.6	1.9	1.2	9.2	2.9	1.2	1.5	11.5	13.3	1	0	0
91	1/29/80 7:00	6.5	3.7	6.7	174.0	49.1	0.78	0.1003	1.0	0.4	0.6	8.6	9.2	2.00	1.56	6.3	0.7834	8.9	1.0	1.0000	0.7	0.7	1.00	0.7	2.9	2.3	12.0	0.7	0.7	2.3	8.6	12.0	0	0	1
92	6/13/79 23:00	5.6	3.0	21.2	184.0	59.1	0.66	0.1003	2.9	1.2	1.5	11.5	13.2	1.16	0.90	15.5	0.7567	28.0	1.0	1.0000	0.9	0.9	1.00	0.6	1.8	1.2	9.2	2.9	1.2	1.5	11.5	13.2	1	0	0
93	7/3/85 21:00	6.4	3.0	17.5	184.0	59.1	0.66	0.1003	2.4	1.0	1.3	11.4	12.8	1.90	1.48	13.6	0.7852	19.9	1.0	1.0000	0.9	0.9	1.00	0.6	2.9	1.9	11.3	0.9	0.6	1.9	8.5	11.3	0	0	1
94	5/2/65 23:00	5.2	2.7	23.3	187.0	62.1	0.61	0.1003	3.0	1.3	1.6	11.4	13.2	0.76	0.60	6.7	0.6925	13.6	1.0	1.0000	0.9	0.9	1.00	0.6	1.2	0.7	8.0	3.0	1.3	1.6	11.4	13.2	1	0	0
95	5/12/68 21:00	6.5	3.6	11.9	182.0	57.1	0.68	0.1003	1.8	0.8	1.0	10.1	11.2	1.92	1.50	8.5	0.7875	12.4	1.0	1.0000	0.9	0.9	1.00	0.6	2.9	2.0	11.4	0.9	0.6	2.0	8.5	11.4	0	0	1
96	2/24/98 7:00	6.1	3.7	17.5	184.0	59.1	0.66	0.1003	2.7	1.1	1.4	11.6	13.2	1.95	1.52	9.8	0.7881	14.2	1.0	1.0000	1.0	1.0	1.00	0.7	2.9	1.9	11.3	1.0	0.7	1.9	8.5	11.3	0	0	1
97	7/17/93 19:00	6.2	3.0	19.2	181.0	56.1	0.69	0.1003	2.6	1.1	1.4	11.6	13.2	1.72	1.34	13.5	0.7918	20.8	1.0	1.0000	0.9	0.9	1.00	0.6	2.7	1.8	11.0	2.6	1.1	1.4	11.6	13.2	1	0	0
98	5/8/89 23:00	5.9	2.6	21.2	180.0	55.1	0.71	0.1003	2.7	1.2	1.5	11.5	13.2	1.34	1.05	14.0	0.7726	23.9	1.0	1.0000	0.8	0.8	1.00	0.6	2.1	1.5	9.9	2.7	1.2	1.5	11.5	13.2	1	0	0
99	4/19/08 20:00	5.1	4.0	19.2	183.0	58.1	0.67	0.1003	3.0	1.3	1.6	11.3	13.2	1.12	0.87	13.9	0.7477	25.2	1.0	1.0000	1.1	1.1	1.00	0.7	1.7	1.2	9.0	3.0	1.3	1.6	11.3	13.2	1	0	0
100	6/30/92 21:00	6.8	1.9	15.9	188.0	63.1	0.63	0.1003	1.8	0.7	0.9	10.4	11.5	1.93	1.51	5.7	0.7939	8.4	1.0	1.0000	0.6	0.6	0.90	0.6	2.8	1.8	11.1	0.6	0.6	1.8	8.5	11.1	0	0	1
101	6/20/97 21:00	6.3	2.8	19.2	182.0	57.1	0.68	0.1003	2.6	1.1	1.4	11.6	13.1	1.80	1.41	13.7	0.7953	20.8	1.0	1.0000	0.9	0.9	1.00	0.6	2.8	1.9	11.2	2.6	1.1	1.4	11.6	13.1	1	0	0
102	2/17/99 10:00	5.4	3.1	21.2	183.0	58.1	0.67	0.1003	2.9	1.3	1.6	11.4	13.1	0.97	0.76	17.9	0.7350	34.2	1.0	1.0000	0.9	0.9	1.00	0.6	1.5	1.0	8.7	2.9	1.3	1.6	11.4	13.1	1	0	0
103	12/20/64 9:00	6.8	2.2	14.4	182.0	57.1	0.68	0.1003	1.7	0.7	0.9	10.2	11.2	1.92	1.50	6.3	0.7960	9.2	1.0	1.0000	0.7	0.6	0.93	0.6	2.8	1.9	11.4	0.6	0.6	1.9	8.5	11.4	0	0	1
104	6/11/72 21:00	7.0	2.0	14.4	188.0	63.1	0.63	0.1003	1.6	0.7	0.9	10.3	11.3	1.81	1.41	10.7	0.7969	16.3	1.0	1.0000	0.6	0.5	0.81	0.4	2.8	1.7	11.1	0.5	0.4	1.7	8.4	11.1	0	0	1
105	10/3/87 18:00	5.7	2.8	21.2	184.0	59.1	0.66	0.1003	2.8	1.2	1.5	11.4	13.1	1.19	0.93	16.7	0.7605	29.8	1.0	1.0000	0.9	0.9	1.00	0.6	1.9	1.2	9.3	2.8	1.2	1.5	11.4	13.1	1	0	0
106	7/9/83 20:00	7.2	1.9	11.9	182.0	57.1	0.68	0.1003	1.3	0.6	0.7	9.8	10.6	1.81	1.41	8.2	0.7973	12.5	1.0	1.0000	0.6	0.4	0.71	0.4	2.7	1.9	11.4	0.4	0.4	1.9	8.4	11.4	0	0	1
107	8/18/72 16:00	4.6	5.4	17.5	179.0	54.1	0.72	0.1003	3.2	1.4	1.7	11.2	13.1	1.10	0.86	14.9	0.7408	27.0	1.0	1.0000	1.3	1.3	1.00	0.9	1.7	1.2	8.9	3.2	1.4	1.7	11.2	13.1	1	0	0
108	12/15/93 10:00	6.1	2.5	21.2	186.0	61.1	0.63	0.1003	2.6	1.1	1.4	11.5	13.1	1.42	1.11	8.7	0.7766	14.6	1.0	1.0000	0.8	0.8	1.00	0.5	2.2	1.4	9.8	2.6	1.1	1.4	11.5	13.1	1	0	0
109	8/6/64 20:00	7.0	2.1	13.1	182.0	57.1	0.68	0.1003	1.5	0.6	0.8	10.1	11.0	1.79	1.40	11.3	0.7970	17.2	1.0	1.0000	0.6	0.5	0.83	0.4	2.7	1.9	11.4	0.5	0.4	1.9	8.4	11.4	0	0	1
110	4/14/06 22:00	5.1	2.7	23.3	203.0	78.1	0.63	0.1003	3.0	1.3	1.6	11.3	13.1	0.71	0.55	6.9	0.6773	14.2	1.0	1.0000	0.9	0.9	1.00	0.7	1.1	0.7	7.8	3.0	1.3	1.6	11.3	13.1	1	0	0
111	9/19/04 12:00	5.6	3.4	19.2	179.0	54.1	0.72	0.1003	2.8	1.2	1.5	11.4	13.1	1.33	1.04	12.8	0.7688	21.9	1.0	1.0000	1.0	1.0	1.00	0.7	2.1	1.5	9.8	2.8	1.2	1.5	11.4	13.1	1	0	0
112	4/17/92 21:00	6.6	1.7	23.3	184.0	59.1	0.66	0.1003	2.4	1.0	1.3	11.6	13.0	1.56	1.21	7.3	0.7855	11.8	1.0	1.0000	0.7	0.7	0.99	0.4	2.3	1.5	10.4	2.4	1.0	1.3	11.6	13.0	1	0	0
113	8/15/97 19:00	6.4	2.7	19.2	179.0	54.1	0.72	0.1003	2.5	1.1	1.3	11.5	13.0	1.80	1.40	13.1	0.7953	19.9	1.0	1.0000	0.8	0.8	1.00	0.6	2.8	2.0	11.4	2.5	1.1	1.3	11.5	13.0	1	0	0
114	6/30/00 20:00	6.9	2.1	15.9	185.0	60.1	0.64	0.1003	1.8	0.8	1.0	10.6	11.7	1.82	1.42	8.7	0.7966	13.1	1.0	1.0000	0.7	0.6	0.87	0.4	2.7	1.8	11.1	0.6	0.4	1.8	8.4	11.1	0	0	1
115	5/20/75 18:00	5.2	5.6	15.9	179.0	54.1	0.72	0.1003	3.0	1.3	1.6	11.2	13.0	1.73	1.35	10.2	0.7864	15.6	1.0	1.0000	1.3	1.3	1.00	0.9	2.6	1.9	10.7	3.0	1.3	1.6	11.2	13.0	1	0	0
116	1/11/01 10:00	6.8	3.3	7.4	191.0	66.1	0.63	0.1003	1.1	0.5	0.6	9.0	9.6	1.84	1.44	7.6	0.7966	11.4	1.0	1.0000	0.7	0.6	0.92	0.5	2.8	1.7	11.0	0.6	0.5	1.7	8.4	11.0	0	0	1
117	12/30/82 8:00	7.4	1.2	15.9	186.0	61.1	0.63	0.1003	1.4	0.6	0.7	10.2	11.0	1.77	1.38	8.2	0.7965	12.7	1.0	1.0000	0.5	0.3	0.51	0.3	2.7	1.7	11.1	0.3	0.3	1.7	8.3	11.1	0	0	1
118	1/29/98 10:00	6.5	2.8	15.9	187.0	62.1	0.61	0.1003	2.1	0.9	1.1	10.7	12.0	1.90	1.49	6.7	0.7965	9.9	1.0	1.0000	0.8	0.8	1.00	0.6	2.8	1.7	10.9	0.8	0.6	1.7	8.5	10.9	0	0	1
119	2/15/86 14:00	2.6	6.7	19.2	192.0	67.1	0.63	0.1003	3.9	1.7	2.1	10.7	13.0			13.8			1.0	1.0000			1.00												
120	2/7/98 6:00	5.8	4.6	15.9	194.0	69.1	0.63	0.1003	2.7	1.2	1.4	11.3	12.9	1.92	1.50	11.4	0.7965	16.8	1.0	1.0000	1.1	1.1	1.00	0.8	2.9	1.8	11.0	1.1	0.8	1.8	8.5	11.0	0	0	1
121	7/19/97 20:00	6.7	2.2	19.2	186.0	61.1	0.63	0.1003	2.3	1.0	1.2	11.3	12.7	1.81	1.41	11.9	0.7964	18.0	1.0	1.0000	0.7	0.7	0.96	0.5	2.8	1.7	11.0	0.7	0.5	1.7	8.4	11.0	0	0	1
122	7/18/89 21:00	6.3	3.3	15.9	179.0	54.1	0.72	0.1003	2.3	1.0	1.2	11.0	12.4	1.86	1.45	11.5	0.7964	17.2	1.0	1.0000	0.9	0.9	1.00	0.6	2.8	2.0	11.5	0.9	0.6	2.0	8.4	11.5	0	0	1
123	10/22/06 8:00	5.5	3.5	19.2	183.0	58.1	0.67	0.1003	2.8	1.2	1.5	11.3	13.0	1.24	0.96	16.3	0.7620	28.7	1.0	1.0000	1.0	1.0	1.00	0.7	1.9	1.3	9.4	2.8	1.2	1.5	11.3	13.0	1	0	0
124	9/6/06 20:00	6.5	2.2	21.2	184.0	59.1	0.66	0.1003	2.5	1.1	1.3	11.5	13.0	1.61	1.26	13.3	0.7889	21.2	1.0	1.0000	0.7	0.7	1.00	0.5	2.5	1.6	10.6	2.5	1.1	1.3	11.5	13.0	1	0	0
125	9/19/69 15:00	5.0	4.8	17.5	179.0	54.1	0.72</																												

# Summary Sheet: Statistical Analysis of TWL

Prepared By:

Q. Wang

MN JN: 9937 City of Malibu FEMA Appeal

4/8/19

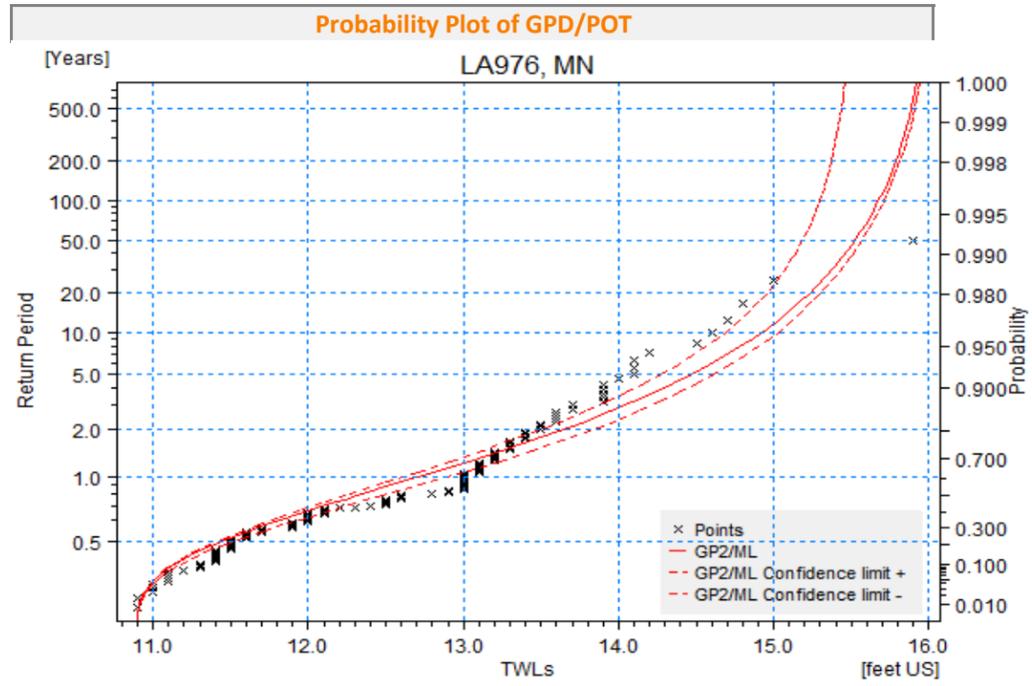
<b>Mapping Transect</b>		25	38	38	42**
<b>Analysis Transect</b>		976	859	859_F	824
<b>2% Annual Chance TWL (50-year) (ft NAVD)</b>		15.7	18.4	14.4	19.6
<b>1% Annual Chance TWL (100-year) (ft NAVD)</b>		15.9	19.3	15.2	20.0
<b>0.2% Annual Chance TWL (500-year) (ft NAVD)</b>		16.1	21.3	17.5	20.8
<b>Statistical Method Used</b>		GPD/POT	GPD/POT	GPD/POT	GPD/POT
<b>Highest 50-year TWL (ft NAVD)</b>		15.9	18.3	15.4	20.3
<b>Assessment of Reasonableness*</b>	Criteria 2-1: Highest 50-year TWLs between 1% and 2% TWLs	Yes	Yes	No	No
	Criteria 2-2: 1% TWLs within 1ft of Highest TWLs	Yes	Yes	Yes	Yes
	Criteria 3: Difference between 0.2% and 1% TWLs less than 3ft	Yes	Yes	Yes	Yes

\* No enough data to assess the reasonableness assessment criteria 1 - 1% TWLs from GEV/AM and GPD/POT less than 3ft. It is also mentioned in IDS#3 that "both methods generally provided reasonable and comparable estimates of extreme TWLs within the study area".

\*\*Being consistent with PFIRM, only intact condition is calculated.

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
52	7/7/1960 20:00	12.0	13.9
59	5/22/1963 20:00	11.7	13.7
84	5/26/1963 22:00	13.3	13.3
109	8/6/1964 20:00	11.4	13.1
103	12/20/1964 9:00	11.4	13.1
94	5/2/1965 23:00	13.2	13.2
32	6/15/1965 21:00	14.5	14.5
6	8/24/1965 19:00	14.1	16.5
33	7/19/1966 22:00	12.5	14.4
42	5/25/1967 22:00	14.1	14.1
29	9/3/1967 20:00	12.5	14.6
95	5/12/1968 21:00	11.4	13.2
126	5/21/1968 18:00	13.0	13.0
40	6/6/1968 18:00	14.2	14.2
7	6/9/1968 20:00	13.9	16.3
85	12/20/1968 9:00	11.6	13.3
69	1/19/1969 9:00	11.5	13.6
67	8/25/1969 19:00	11.5	13.6
81	9/15/1969 11:00	13.4	13.4
125	9/19/1969 15:00	13.0	13.0
56	12/9/1969 8:00	12.0	13.8
65	4/12/1970 1:00	13.6	13.6
31	11/29/1970 9:00	12.0	14.5
104	6/11/1972 21:00	11.1	13.1
107	8/18/1972 16:00	13.1	13.1
48	8/23/1972 20:00	12.1	14.0
26	6/30/1973 21:00	13.0	14.8
87	7/27/1973 19:00	11.5	13.3
55	8/22/1973 16:00	13.9	13.9
17	1/8/1974 8:00	12.6	15.2
115	5/20/1975 18:00	13.0	13.0
25	1/10/1978 9:00	12.3	14.9
70	2/6/1978 8:00	11.6	13.6
16	2/9/1978 23:00	12.5	15.2
5	3/1/1978 2:00	14.8	16.6
92	6/13/1979 23:00	13.2	13.2
91	1/29/1980 7:00	12.0	13.3
11	2/14/1980 7:00	12.9	15.8
28	2/17/1980 10:00	12.1	14.6
21	5/11/1980 19:00	15.0	15.0
4	5/14/1980 21:00	13.6	16.7
64	1/20/1981 9:00	11.4	13.6

Extreme Analysis Results				
Return Period (year)	Estimated Extreme TWLs (ft NAVD)		Standard Deviation of Estimated Extremes (ft)	
	GPD/POT	GEV/AM	GPD/POT	GEV/AM
50	15.5		0.19	
100	15.7		0.205	
500	15.9		0.237	



\*GP2/ML stands for Generalised Pareto Distribution with Maximum Likelihood Estimation Method.

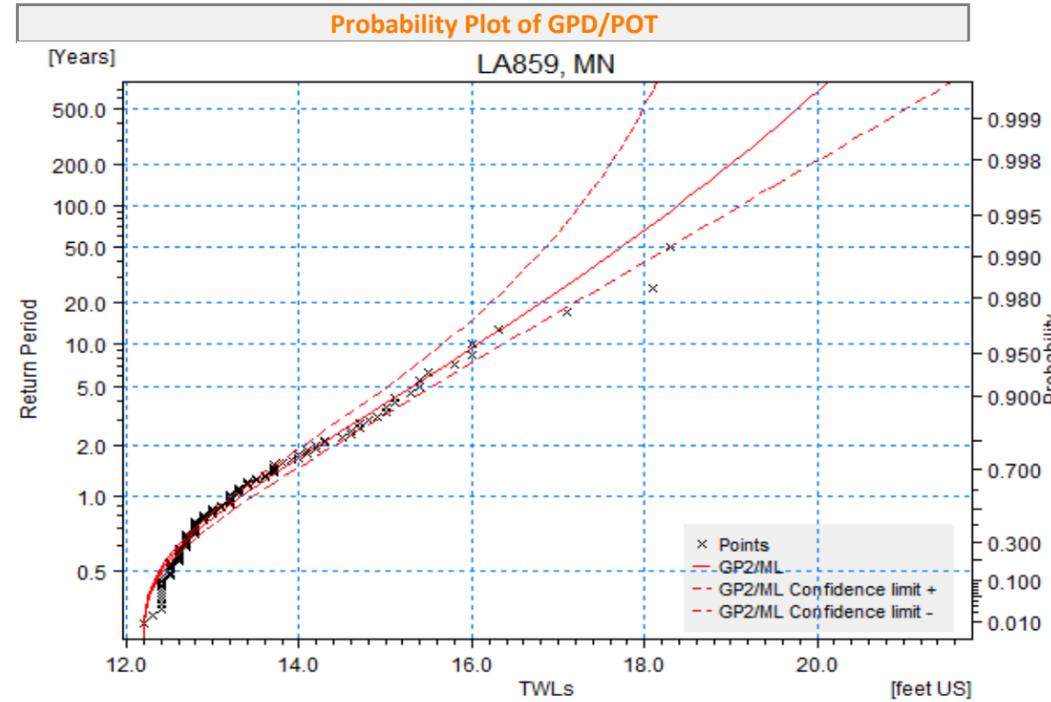
**Input Data for Extreme Analysis**

No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
22	6/28/1981 18:00	13.0	15.0
9	8/16/1982 19:00	13.5	16.0
23	11/30/1982 8:00	12.4	14.9
117	12/30/1982 8:00	11.1	13.0
2	1/29/1983 9:00	14.6	18.1
1	3/1/1983 23:00	15.9	20.1
63	6/11/1983 21:00	11.5	13.6
106	7/9/1983 20:00	11.4	13.1
77	8/8/1983 21:00	11.6	13.4
53	6/2/1985 20:00	11.7	13.9
93	7/3/1985 21:00	11.3	13.2
60	7/16/1985 20:00	11.9	13.7
20	7/29/1985 19:00	12.6	15.1
54	11/12/1985 8:00	11.6	13.9
119	2/15/1986 14:00	13.0	13.0
71	7/10/1987 20:00	11.4	13.6
105	10/3/1987 18:00	13.1	13.1
66	10/8/1987 9:00	11.5	13.6
57	12/17/1987 6:00	11.5	13.8
3	1/18/1988 8:00	14.0	17.2
44	5/4/1989 20:00	11.9	14.1
98	5/8/1989 23:00	13.2	13.2
75	6/20/1989 22:00	13.5	13.5
122	7/18/1989 21:00	11.5	13.0
127	2/28/1991 9:00	10.9	13.0
47	1/19/1992 8:00	11.7	14.0
13	3/20/1992 22:00	13.0	15.6
112	4/17/1992 21:00	13.0	13.0
100	6/30/1992 21:00	11.1	13.2
73	1/7/1993 8:00	11.4	13.6
18	2/8/1993 10:00	12.5	15.2
97	7/17/1993 19:00	13.2	13.2
108	12/15/1993 10:00	13.1	13.1
19	6/14/1995 22:00	12.5	15.1
83	6/30/1996 20:00	11.4	13.3
72	7/25/1996 17:00	13.6	13.6
88	4/9/1997 23:00	13.3	13.3
35	6/2/1997 19:00	12.0	14.3
76	6/5/1997 21:00	11.3	13.5
101	6/20/1997 21:00	13.1	13.1
121	7/19/1997 20:00	11.0	13.0
68	8/1/1997 20:00	13.6	13.6

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
113	8/15/1997 19:00	13.0	13.0
41	10/3/1997 10:00	14.1	14.1
14	11/14/1997 8:00	12.9	15.5
118	1/29/1998 10:00	10.9	13.0
8	2/3/1998 3:00	13.5	16.2
120	2/7/1998 6:00	11.0	13.0
96	2/24/1998 7:00	11.3	13.2
27	4/25/1998 20:00	14.7	14.7
62	5/25/1998 21:00	13.7	13.7
90	6/11/1998 22:00	13.3	13.3
82	7/11/1998 22:00	13.3	13.3
49	10/2/1998 19:00	13.9	13.9
102	2/17/1999 10:00	13.1	13.1
46	5/15/1999 21:00	12.0	14.0
51	10/6/1999 19:00	13.9	13.9
114	6/30/2000 20:00	11.1	13.0
116	1/11/2001 10:00	11.0	13.0
89	7/20/2001 21:00	11.2	13.3
78	9/7/2002 21:00	13.4	13.4
50	4/18/2003 22:00	13.9	13.9
79	5/3/2003 21:00	13.4	13.4
36	10/26/2003 9:00	12.1	14.3
80	5/7/2004 23:00	13.4	13.4
24	6/3/2004 21:00	12.8	14.9
111	9/19/2004 12:00	13.1	13.1
30	12/28/2004 9:00	12.6	14.5
38	1/9/2005 8:00	11.9	14.2
34	6/21/2005 20:00	12.0	14.4
61	7/21/2005 21:00	11.6	13.7
15	8/17/2005 19:00	13.2	15.3
45	9/16/2005 20:00	11.9	14.0
10	1/2/2006 10:00	13.0	15.9
110	4/14/2006 22:00	13.1	13.1
58	5/27/2006 21:00	13.7	13.7
124	9/6/2006 20:00	13.0	13.0
123	10/22/2006 8:00	13.0	13.0
86	2/25/2008 0:00	13.3	13.3
99	4/19/2008 20:00	13.2	13.2
74	6/4/2008 21:00	11.5	13.5
12	7/2/2008 20:00	12.8	15.7
37	7/30/2008 19:00	11.9	14.2
39	2/7/2009 7:00	12.1	14.2
43	7/23/2009 22:00	12.2	14.1

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
53	7/7/1960 20:00	13.2	13.2
73	4/25/1963 22:00	12.8	12.8
69	5/22/1963 20:00	12.9	12.9
74	6/21/1963 21:00	12.8	12.8
109	6/8/1964 20:00	12.4	12.4
96	12/20/1964 9:00	12.6	12.6
10	8/24/1965 19:00	15.5	15.5
32	7/19/1966 22:00	13.9	13.9
28	9/3/1967 20:00	14.1	14.1
49	5/12/1968 21:00	13.3	13.3
85	6/6/1968 18:00	12.7	12.7
7	6/9/1968 20:00	15.8	15.8
71	1/19/1969 9:00	12.7	12.8
77	8/25/1969 19:00	12.8	12.8
79	9/16/1969 11:00	12.8	12.8
103	9/20/1969 16:00	12.5	12.5
45	12/9/1969 8:00	13.4	13.4
33	11/29/1970 9:00	13.7	13.8
101	4/25/1971 21:00	12.5	12.5
76	6/10/1972 20:00	12.8	12.8
39	8/23/1972 20:00	13.7	13.7
58	1/19/1973 9:00	12.9	13.2
52	6/30/1973 21:00	13.2	13.2
94	7/27/1973 19:00	12.6	12.6
59	8/23/1973 17:00	13.1	13.1
16	1/8/1974 8:00	15.0	15.1
60	12/28/1974 8:00	12.8	13.1
47	5/20/1975 18:00	13.3	13.3
15	1/10/1978 9:00	15.0	15.2
48	2/6/1978 8:00	13.3	13.3
12	2/10/1978 0:00	15.3	15.4
19	3/1/1978 2:00	14.8	14.8
44	3/5/1978 6:00	13.2	13.4
8	2/14/1980 7:00	15.4	15.6
5	2/17/1980 10:00	16.0	16.3
92	5/11/1980 19:00	12.6	12.6
4	5/14/1980 21:00	16.3	16.3
23	1/20/1981 9:00	14.2	14.5
102	6/2/1981 21:00	12.5	12.5
25	6/28/1981 18:00	14.3	14.3
20	8/17/1982 20:00	14.7	14.7
110	9/27/1982 17:00	12.4	12.4

Extreme Analysis Results				
Return Period (year)	Estimated Extreme TWLs (ft NAVD)		Standard Deviation of Estimated Extremes (ft)	
	GPD/POT	GEV/AM	GPD/POT	GEV/AM
50	17.7		0.7	
100	18.4		0.9	
500	19.8		1.5	



\*GP2/ML stands for Generalised Pareto Distribution with Maximum Likelihood Estimation Method.

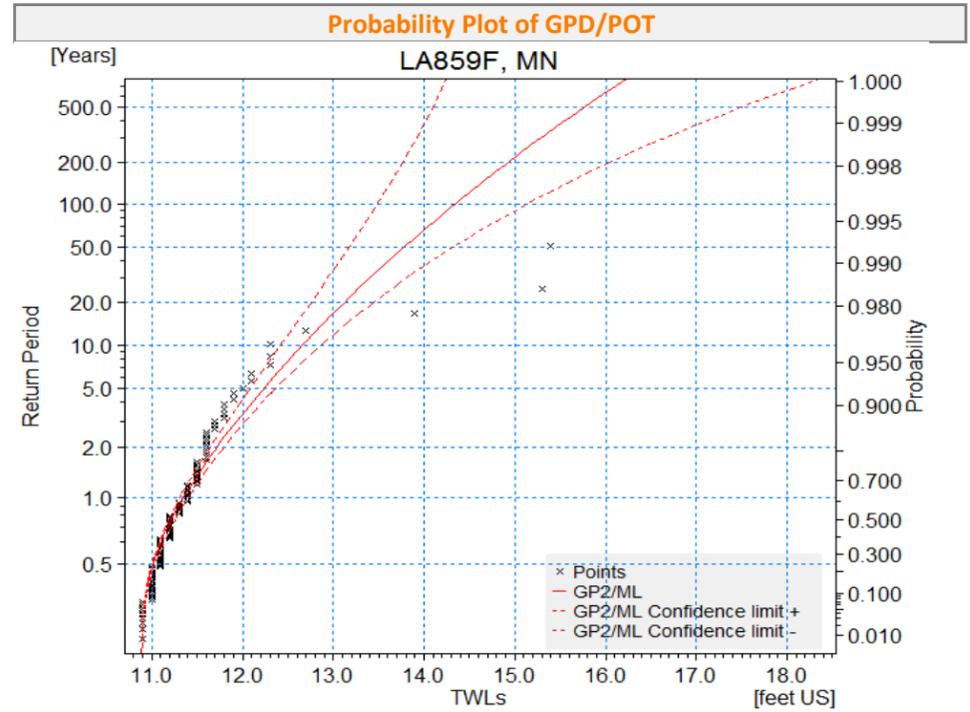
Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
11	11/30/1982 8:00	14.6	15.4
107	12/30/1982 8:00	12.4	12.4
2	1/29/1983 9:00	18.1	18.3
1	3/1/1983 23:00	18.3	18.4
113	7/9/1983 20:00	12.4	12.4
95	8/8/1983 21:00	12.6	12.6
97	6/3/1985 21:00	12.5	12.5
114	6/18/1985 21:00	12.4	12.4
64	7/16/1985 20:00	13.0	13.0
21	7/29/1985 19:00	14.7	14.7
40	11/11/1985 7:00	13.6	13.6
115	7/20/1986 20:00	12.3	12.4
108	7/10/1987 20:00	12.4	12.4
61	10/8/1987 9:00	13.0	13.0
13	12/17/1987 6:00	15.1	15.2
3	1/18/1988 8:00	17.1	17.6
70	5/5/1989 21:00	12.8	12.9
87	7/18/1989 21:00	12.7	12.7
38	2/28/1991 9:00	13.7	13.7
112	6/24/1991 19:00	12.4	12.4
75	1/19/1992 8:00	12.7	12.8
82	3/20/1992 22:00	12.7	12.7
34	1/7/1993 8:00	13.5	13.8
29	1/18/1993 6:00	13.8	14.0
51	2/5/1993 8:00	13.1	13.3
14	2/8/1993 10:00	15.1	15.2
62	2/19/1993 8:00	13.0	13.0
106	6/5/1993 21:00	12.4	12.5
104	12/15/1993 10:00	12.4	12.5
55	4/25/1994 21:00	13.2	13.2
66	1/3/1995 10:00	12.7	13.0
26	6/15/1995 23:00	14.2	14.2
99	6/30/1996 20:00	12.5	12.5
56	7/26/1996 18:00	13.2	13.2
30	6/2/1997 19:00	14.0	14.0
78	6/21/1997 21:00	12.8	12.8
100	8/2/1997 20:00	12.5	12.5
93	10/3/1997 10:00	12.6	12.6
90	11/11/1997 6:00	12.6	12.6
17	11/14/1997 8:00	14.9	14.9
91	1/10/1998 7:00	12.2	12.6
65	1/30/1998 10:00	12.9	13.0

**Input Data for Extreme Analysis**

No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
6	2/3/1998 3:00	16.0	16.1
18	2/7/1998 6:00	14.6	14.8
35	2/24/1998 7:00	13.7	13.8
67	4/25/1998 20:00	12.9	12.9
80	8/6/1998 20:00	12.7	12.7
36	5/15/1999 21:00	13.7	13.7
84	6/30/2000 20:00	12.7	12.7
50	1/11/2001 10:00	13.1	13.3
68	7/20/2001 21:00	12.8	12.9
72	5/15/2003 20:00	12.8	12.8
83	10/27/2003 10:00	12.7	12.7
111	5/4/2004 21:00	12.4	12.4
31	6/4/2004 22:00	14.0	14.0
41	12/28/2004 9:00	13.5	13.5
42	1/9/2005 8:00	13.3	13.5
81	2/21/2005 7:00	12.6	12.7
105	6/6/2005 20:00	12.5	12.5
27	6/21/2005 20:00	14.1	14.1
86	7/21/2005 21:00	12.7	12.7
22	8/17/2005 19:00	14.5	14.5
46	9/16/2005 20:00	13.4	13.4
9	1/2/2006 10:00	15.4	15.6
37	5/26/2006 20:00	13.6	13.7
116	5/21/2008 21:00	12.4	12.4
43	6/4/2008 21:00	13.4	13.4
24	7/3/2008 21:00	14.3	14.3
54	7/30/2008 19:00	13.2	13.2
89	9/4/2008 11:00	12.6	12.6
63	12/13/2008 9:00	13.0	13.0
88	2/7/2009 8:00	12.6	12.6
98	6/21/2009 20:00	12.5	12.5
57	7/23/2009 22:00	13.2	13.2

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
64	7/7/1960 20:00	11.2	11.2
99	4/25/1963 22:00	11.1	11.1
48	5/22/1963 20:00	11.4	11.4
68	6/20/1963 20:00	11.2	11.2
125	8/5/1964 19:00	10.9	10.9
115	12/20/1964 9:00	11.0	11.0
83	5/3/1965 22:00	11.1	11.1
37	6/15/1965 21:00	11.5	11.5
12	8/24/1965 19:00	11.9	11.9
118	2/4/1966 8:00	11.0	11.0
55	7/19/1966 22:00	11.3	11.3
34	5/25/1967 22:00	11.5	11.5
74	9/3/1967 20:00	11.2	11.2
8	6/8/1968 19:00	12.1	12.1
60	8/25/1969 19:00	11.3	11.3
92	12/9/1969 8:00	11.1	11.1
131	4/25/1971 21:00	10.9	10.9
82	6/9/1972 19:00	11.1	11.1
77	8/22/1972 20:00	11.2	11.2
84	11/20/1972 8:00	11.1	11.1
17	6/30/1973 20:00	11.8	11.8
98	7/28/1973 20:00	11.1	11.1
72	8/23/1973 17:00	11.2	11.2
38	1/8/1974 8:00	11.5	11.5
126	4/25/1975 21:00	10.9	10.9
79	5/20/1975 18:00	11.2	11.2
129	1/7/1978 7:00	10.9	10.9
9	1/10/1978 9:00	12.1	12.1
51	2/6/1978 8:00	11.4	11.4
28	2/10/1978 0:00	11.6	11.6
89	3/1/1978 2:00	11.1	11.1
119	8/17/1978 20:00	11.0	11.0
19	2/14/1980 7:00	11.7	11.7
6	2/17/1980 10:00	12.3	12.3
27	5/11/1980 19:00	11.6	11.6
4	5/14/1980 21:00	12.7	12.7
32	1/20/1981 9:00	11.5	11.5
127	5/6/1981 23:00	10.9	10.9
40	6/2/1981 21:00	11.5	11.5
46	6/29/1981 19:00	11.4	11.4
105	11/13/1981 9:00	11.0	11.0
86	6/23/1982 22:00	11.1	11.1

Extreme Analysis Results				
Return Period (year)	Estimated Extreme TWLs (ft NAVD)		Standard Deviation of Estimated Extremes (ft)	
	GPD/POT	GEV/AM	GPD/POT	GEV/AM
50	13.8		0.6	
100	14.3		0.8	
500	15.8		1.7	



\*GP2/ML stands for Generalised Pareto Distribution with Maximum Likelihood Estimation Method.

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
10	8/16/1982 19:00	12.0	12.0
16	11/30/1982 8:00	11.6	11.8
26	12/30/1982 8:00	11.6	11.6
2	1/29/1983 9:00	15.3	15.4
1	3/1/1983 23:00	15.4	15.5
100	6/24/1983 20:00	11.1	11.1
58	8/8/1983 21:00	11.3	11.3
67	9/4/1983 19:00	11.2	11.2
107	12/20/1983 9:00	11.0	11.0
53	6/3/1985 21:00	11.4	11.4
114	7/2/1985 21:00	11.0	11.0
122	7/16/1985 20:00	11.0	11.0
15	7/29/1985 19:00	11.8	11.8
93	11/11/1985 7:00	11.1	11.1
96	12/11/1985 8:00	11.1	11.1
132	6/20/1986 19:00	10.9	10.9
56	7/20/1986 20:00	11.3	11.3
31	7/10/1987 20:00	11.5	11.5
97	8/8/1987 20:00	11.1	11.1
121	10/8/1987 9:00	11.0	11.0
30	12/17/1987 6:00	11.6	11.6
3	1/18/1988 8:00	13.9	14.1
59	5/5/1989 21:00	11.3	11.3
75	6/20/1989 22:00	11.2	11.2
120	7/18/1989 21:00	11.0	11.0
108	7/31/1989 20:00	11.0	11.0
50	7/11/1991 20:00	11.4	11.4
24	1/19/1992 8:00	11.6	11.6
106	3/21/1992 23:00	11.0	11.0
42	4/18/1992 22:00	11.5	11.5
123	7/28/1992 20:00	11.0	11.0
116	11/23/1992 8:00	11.0	11.0
71	1/18/1993 6:00	11.2	11.2
101	2/5/1993 8:00	11.1	11.1
45	2/8/1993 10:00	11.4	11.4
102	6/5/1993 21:00	11.1	11.1
88	10/15/1993 8:00	11.1	11.1
90	11/13/1993 8:00	11.1	11.1
39	12/15/1993 10:00	11.5	11.5
35	4/25/1994 21:00	11.5	11.5
11	6/13/1995 21:00	11.9	11.9
91	7/10/1995 19:00	11.1	11.1

**Input Data for Extreme Analysis**

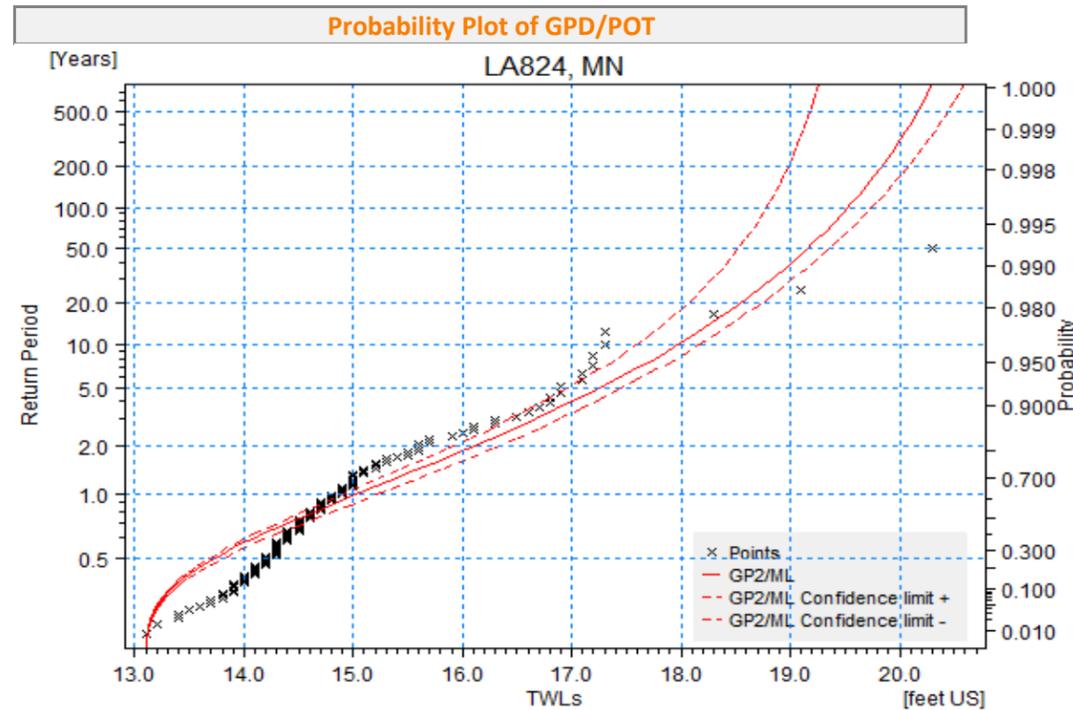
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
69	6/29/1996 20:00	11.2	11.2
104	7/26/1996 18:00	11.0	11.0
44	6/1/1997 19:00	11.4	11.4
63	6/20/1997 21:00	11.2	11.2
70	7/20/1997 21:00	11.2	11.2
66	8/2/1997 20:00	11.2	11.2
76	8/15/1997 19:00	11.2	11.2
95	10/3/1997 10:00	11.1	11.1
47	11/11/1997 6:00	11.4	11.4
7	11/14/1997 8:00	12.3	12.3
52	1/30/1998 10:00	11.4	11.4
5	2/3/1998 3:00	12.3	12.4
20	2/7/1998 6:00	11.7	11.7
43	2/24/1998 7:00	11.4	11.4
23	4/25/1998 20:00	11.6	11.6
113	5/26/1998 21:00	11.0	11.0
110	7/10/1998 21:00	11.0	11.0
128	10/4/1998 20:00	10.9	10.9
14	5/15/1999 21:00	11.8	11.8
112	6/14/1999 21:00	11.0	11.0
61	6/30/2000 20:00	11.3	11.3
49	7/20/2001 21:00	11.4	11.4
73	5/15/2003 20:00	11.2	11.2
124	7/11/2003 19:00	10.9	10.9
41	10/26/2003 9:00	11.5	11.5
87	1/21/2004 8:00	11.1	11.1
36	6/4/2004 22:00	11.5	11.5
117	7/2/2004 21:00	11.0	11.0
85	7/31/2004 21:00	11.1	11.1
130	9/19/2004 12:00	10.9	10.9
94	6/6/2005 20:00	11.1	11.1
22	6/20/2005 19:00	11.6	11.6
13	7/21/2005 21:00	11.8	11.8
18	8/17/2005 19:00	11.7	11.7
65	9/16/2005 20:00	11.2	11.2
21	1/2/2006 10:00	11.6	11.7
57	5/25/2006 20:00	11.3	11.3
54	9/6/2006 20:00	11.3	11.3
81	1/21/2008 8:00	11.2	11.2
25	6/3/2008 20:00	11.6	11.6
111	6/6/2008 22:00	11.0	11.0
29	7/3/2008 21:00	11.6	11.6

**Input Data for Extreme Analysis**

<b>No</b>	<b>Date &amp; Time</b>	<b>Revised TWL (with oblique wave impact) (ft NAVD)</b>	<b>PFIRM TWL (ft NAVD)</b>
62	7/31/2008 20:00	11.3	11.3
109	12/13/2008 9:00	11.0	11.0
78	2/7/2009 8:00	11.2	11.2
33	7/23/2009 22:00	11.5	11.5
80	10/18/2009 8:00	11.2	11.2
103	12/2/2009 8:00	11.1	11.1

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
111	7/8/1960 21:00	14.2	14.3
78	3/25/1961 4:00	14.7	14.7
94	5/20/1962 21:00	14.5	14.5
101	4/25/1963 22:00	14.3	14.4
95	5/22/1963 21:00	14.5	14.5
120	5/4/1965 0:00	14.2	14.2
18	6/15/1965 21:00	16.8	16.8
20	8/24/1965 19:00	16.6	16.7
52	7/19/1966 22:00	15.0	15.1
97	4/22/1967 7:00	14.4	14.4
109	5/26/1967 23:00	14.3	14.3
44	9/3/1967 20:00	15.1	15.2
46	5/12/1968 21:00	15.1	15.2
24	6/6/1968 18:00	16.0	16.0
10	6/9/1968 20:00	17.1	17.2
114	1/19/1969 9:00	14.0	14.3
128	9/20/1969 17:00	14.0	14.1
68	12/9/1969 8:00	14.7	14.8
131	4/12/1970 1:00	14.1	14.1
37	11/29/1970 9:00	15.1	15.4
127	6/10/1972 20:00	13.8	14.1
39	8/23/1972 20:00	15.2	15.3
51	1/19/1973 9:00	14.0	15.1
76	6/30/1973 20:00	14.7	14.7
74	8/23/1973 17:00	14.7	14.7
133	11/25/1973 8:00	14.1	14.1
130	1/5/1974 6:00	13.5	14.1
19	1/8/1974 8:00	16.3	16.8
72	12/28/1974 8:00	13.6	14.7
117	4/25/1975 21:00	14.3	14.3
38	5/20/1975 18:00	15.2	15.3
79	4/14/1976 21:00	14.3	14.7
14	1/10/1978 9:00	16.3	17.0
8	2/10/1978 0:00	17.2	17.5
17	3/1/1978 2:00	16.8	16.8
28	3/5/1978 6:00	14.9	15.9
121	1/6/1979 4:00	13.4	14.2
86	12/31/1979 7:00	13.8	14.6
15	2/14/1980 7:00	16.7	17.0
4	2/17/1980 10:00	17.2	18.3
66	2/21/1980 1:00	13.9	14.9
12	5/11/1980 19:00	17.1	17.1

Extreme Analysis Results				
Return Period (year)	Estimated Extreme TWLs (ft NAVD)		Standard Deviation of Estimated Extremes (ft)	
	GPD/POT	GEV/AM	GPD/POT	GEV/AM
50	19.2		0.4	
100	19.5		0.5	
500	20.2		0.6	



\*GP2/ML stands for Generalised Pareto Distribution with Maximum Likelihood Estimation Method.

**Input Data for Extreme Analysis**

No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
6	5/14/1980 21:00	17.3	17.8
21	1/20/1981 9:00	15.6	16.6
58	6/29/1981 19:00	15.0	15.0
48	8/17/1982 20:00	15.0	15.2
102	9/27/1982 17:00	14.2	14.4
13	12/1/1982 8:00	15.9	17.1
2	1/27/1983 8:00	19.1	20.5
29	1/30/1983 10:00	14.6	15.8
82	2/13/1983 9:00	13.9	14.6
1	3/1/1983 23:00	20.3	21.4
98	5/10/1983 20:00	14.4	14.4
125	6/3/1985 21:00	13.8	14.2
34	7/30/1985 20:00	15.3	15.6
70	2/16/1986 1:00	14.8	14.8
99	10/8/1987 9:00	14.2	14.4
7	12/17/1987 6:00	16.9	17.7
3	1/18/1988 8:00	18.3	19.7
124	4/16/1988 21:00	13.9	14.2
103	5/13/1988 19:00	14.4	14.4
129	6/5/1988 0:00	14.1	14.1
132	12/25/1988 10:00	14.1	14.1
126	7/18/1989 21:00	14.1	14.2
30	2/28/1991 9:00	15.5	15.7
63	1/19/1992 8:00	14.2	14.9
113	2/11/1992 2:00	13.4	14.3
108	3/2/1992 8:00	14.3	14.3
80	3/20/1992 22:00	14.4	14.7
69	4/18/1992 22:00	14.8	14.8
43	1/7/1993 8:00	14.5	15.2
27	1/18/1993 6:00	14.9	15.9
40	2/5/1993 8:00	14.4	15.3
16	2/8/1993 10:00	16.5	17.0
54	2/19/1993 8:00	14.9	15.1
88	6/5/1993 21:00	14.5	14.5
104	2/8/1994 7:00	13.7	14.4
110	4/26/1994 21:00	14.0	14.3
55	1/3/1995 10:00	14.0	15.1
61	1/11/1995 6:00	13.9	14.9
25	6/15/1995 23:00	15.6	16.0
91	7/26/1996 18:00	14.4	14.5
42	6/2/1997 19:00	15.0	15.2
100	8/2/1997 20:00	14.4	14.4

Input Data for Extreme Analysis			
No	Date & Time	Revised TWL (with oblique wave impact) (ft NAVD)	PFIRM TWL (ft NAVD)
75	10/3/1997 10:00	14.7	14.7
23	11/14/1997 8:00	15.7	16.1
60	12/7/1997 4:00	14.3	15.0
115	1/10/1998 7:00	13.1	14.3
32	1/30/1998 10:00	14.8	15.6
5	2/3/1998 3:00	17.3	18.0
11	2/7/1998 6:00	16.1	17.2
26	2/24/1998 7:00	15.5	15.9
22	4/25/1998 22:00	16.1	16.1
134	5/12/1998 21:00	14.1	14.1
85	6/11/1998 22:00	14.6	14.6
92	7/11/1998 22:00	14.5	14.5
96	2/16/1999 9:00	14.5	14.5
33	5/15/1999 21:00	15.6	15.6
59	10/6/1999 19:00	15.0	15.0
112	5/5/2000 22:00	14.3	14.3
50	1/11/2001 10:00	14.5	15.2
81	4/21/2001 20:00	14.7	14.7
119	7/20/2001 21:00	13.9	14.3
56	12/17/2002 7:00	14.3	15.1
116	12/20/2002 8:00	13.7	14.3
35	2/26/2003 6:00	15.4	15.4
122	4/22/2003 1:00	14.2	14.2
31	5/3/2003 21:00	15.7	15.7
90	5/15/2003 20:00	14.3	14.5
123	5/8/2004 23:00	14.2	14.2
57	6/4/2004 22:00	14.9	15.0
41	12/28/2004 9:00	15.2	15.2
45	1/8/2005 7:00	14.6	15.2
71	1/11/2005 9:00	13.2	14.8
73	2/21/2005 7:00	14.3	14.7
67	6/5/2005 20:00	14.9	14.9
47	6/21/2005 20:00	15.0	15.2
53	8/17/2005 19:00	15.0	15.1
106	9/16/2005 20:00	14.1	14.4
9	1/2/2006 10:00	16.9	17.5
49	5/25/2006 19:00	14.8	15.2
87	4/10/2007 1:00	14.6	14.6
84	5/20/2007 23:00	14.6	14.6
93	7/1/2007 21:00	14.5	14.5
83	2/24/2008 22:00	14.6	14.6
107	4/19/2008 20:00	14.3	14.3

**Input Data for Extreme Analysis**

<b>No</b>	<b>Date &amp; Time</b>	<b>Revised TWL (with oblique wave impact) (ft NAVD)</b>	<b>PFIRM TWL (ft NAVD)</b>
77	5/21/2008 21:00	14.5	14.7
65	6/4/2008 21:00	14.7	14.9
36	7/3/2008 21:00	15.3	15.4
118	7/18/2008 21:00	14.3	14.3
64	7/30/2008 19:00	14.4	14.9
89	11/10/2008 6:00	14.5	14.5
62	12/13/2008 9:00	14.8	14.9
105	5/25/2009 21:00	14.4	14.4

## Summary Sheet Overtopping Calculations

Calculated By: Q. Wang  
4/8/2019

MN JN: 9937 City of Malibu Appeal TWL OT Calcs

### Data From IDS 3 and IDS 4

Mapping Transect	Analysis Transect	Shoretype	1% TWL	Crest Elevation (ft NAVD)	TWL-Crest (ft)	DWL 2% (ft NAVD)	Peak Wave Period (s)	Landward Slope	Am	R'/Z' <sub>c</sub>	Type	Y <sub>g</sub>	Y	Y <sub>o</sub>	Second VE Zone BFE (ft NAVD)	AO Zone Depth (ft)
25	976	Bluff	20	16.3	3.8	9.5	15.8	0.22	0.6	1.6	Splash	6.7	6.7	18.1	17.0	1.0
38	859	Revetment+Bluff	20	17	2.9	9.9	14.3	0.04	0.9	1.4	Splash	11.6	18.0	32.7	17.5	1.0
42	824_F*	Bluff	28	23	5.4	9.2	13.3	0.05	0.9	1.4	Splash	12.3	17.5	31.1	24.7	1.0

Y<sub>g</sub> = Y<sub>g, outer</sub>: Landward Extent of splashdown measured from barrier crest

Y: Landward extent of Secondary VE Zone measured from barrier crest

Y<sub>o</sub>: Landward extent of AO Zone measured from barrier crest

\* IDS 3 and IDS 4 reports are based on previous results. In the most recent FEMA updates, only intact condition is considered at Transect 42/LA824.

### Appeal TWL Overtopping Results

Mapping Transect	Analysis Transect	Shoretype	1% TWL	Crest Elevation (ft NAVD)	TWL-Crest (ft)	*Average DWL 2% (ft NAVD)	*Average Peak Wave Period (s)	Landward Slope	Am	R'/Z' <sub>c</sub>	Type	Y <sub>g</sub>	Y	Y <sub>o</sub>	Second VE Zone BFE (ft NAVD)	AO Zone Depth (ft)
25**	976	Bluff	16	16.3	3.8	9.5	15.8	0.22	0.56	0.9	Splash	-	-	-	-	-
38	859	Revetment+Bluff	19	17	2.9	9.9	14.3	0.04	0.92	1.3	Splash	5.5	1.1	21.1	17.5	1.8
42**	824	Bluff	20	23	5.4	9.2	13.3	0.05	0.9	0.8	Splash	-	-	-	-	-

Y<sub>g</sub> = Y<sub>g, outer</sub>: Landward Extent of splashdown measured from barrier crest

Y: Landward extent of Secondary VE Zone measured from barrier crest

Y<sub>o</sub>: Landward extent of AO Zone measured from barrier crest

\*The values reported in IDS3 (2016) are the average associated with the 50 annual (water year) maximum TWL events, Revised Average Peak DWL2% was calculated from the average of the events used in the 1% TWL statistical analysis, sensitivity testing shows this difference between these averaging methods to be insignificant.

\*\* TWL is less or equal the crest elevation, no overtopping

# Transect 38 SPLASH Overtopping Calculation

Calculated By: Q.Wang

MN JN: 9937

OT Calc'd with Appeal TWL's

4/6/2019

$\Delta R = TWL - E_{crest}$

manually entered/solved variables

- TWL = 19 ft
- Crest El = 17 ft
- delta R = 2.306 ft
- T = 14.3 sec
- Am = 0.92
- g = 32.174 ft/s<sup>2</sup>

Table 27 IDS3 (Crest Elevation)

Table 27 IDS3 (Peak Wave Period)

Table 27 IDS3 (A<sub>m</sub>)

- Calculate the excess potential runup,  $\Delta R = R - z_c$ ,  $V_c \cos \alpha$  and  $h_c$ .  $V_c = 1.1\sqrt{g\Delta R}$  and  $h_c = 0.38\Delta R$ . In the case of a vertical seawall, apply Equations D.4.5-9 and D.4.5-19 replacing the numerator:  $\tan \alpha$  by 1.0 for calculation of the excess runup,  $\Delta R$ .

- Slope = 0.602428
- rise = 10.08 ft
- run = 16.73 ft
- Aplha = 0.542203 rad      31.06595 deg

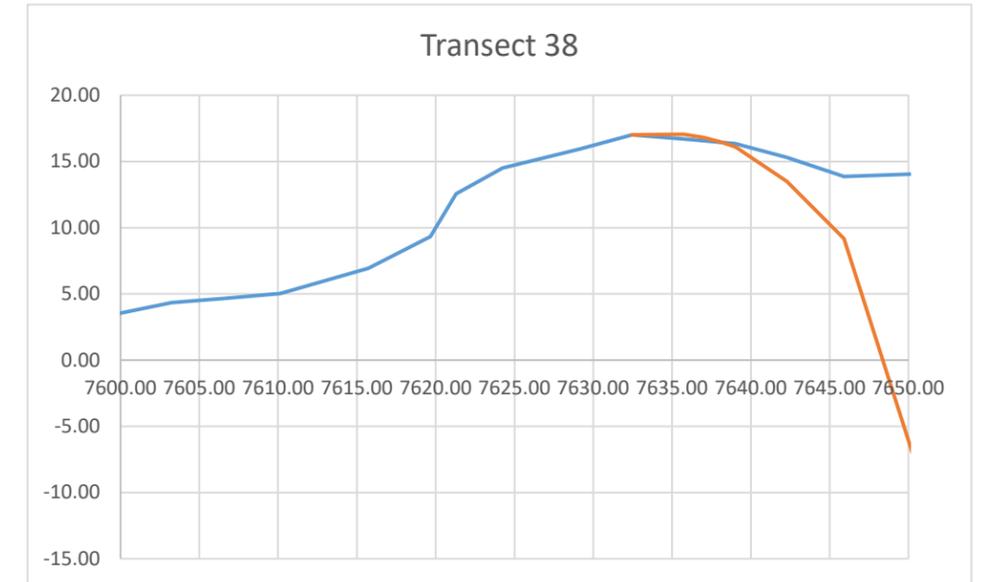
- V<sub>c</sub> = 9.474905 ft/sec
- h<sub>c</sub> = 0.87628 ft
- V<sub>c</sub>cos(a) = 8.115957 ft/sec
- V<sub>c</sub>sin(a) = 4.889281 ft/sec

- Estimate, based on data, the associated onshore wind component,  $W_y$ . Use  $W_y = 44$  ft/sec as a minimum.

$W_y = 44$  ft/s      **IDS 3**

- Calculate an enhanced onshore water velocity component (denoted by prime):  $(V_c \cos \alpha)' = V_c \cos \alpha + 0.3(W_y - V_c \cos \alpha)$ . In the case of a vertical seawall, this simplifies to  $(V_c \cos \alpha)' = 0.3W_y$ .

$(V_c \cos \alpha)' = 18.88117$  ft/sec



$Y_g =$  Intersection-crest  
 $Y_g =$  **5.55 ft**      **RESULT "Y<sub>g</sub>"**

**Cross-shore Elevation (ft NAVD88)**

7183.64	-16.45
7190.20	-16.43
7208.57	-14.09
7421.50	-6.64
7446.10	-5.48
7487.44	-3.60
7568.15	0.25
7572.09	0.62
7575.70	1.08
7579.30	1.13
7582.58	1.48
7586.19	1.80
7589.80	2.12
7593.08	2.30
7597.35	2.91
7603.25	4.35
7606.53	4.65
7610.14	5.03
7615.72	6.93
7619.66	9.32

5. BakerAECOM followed Section D.4.5.2.5.1 of the *Pacific Guidelines* to evaluate the characteristics of the splashdown jet, including its initial velocity and flow depth. An onshore wind component of 44 ft/s (30 mph) was used, which is the minimum recommended wind speed in the *Pacific Guidelines* and is assumed to be a reasonable estimate of wind conditions during a coastal storm event in southern CA. The *Pacific Guidelines* present a graphical solution (Figure D.4.5-15) for the landward extent of splashdown ( $Y_{G,Outer}$ ) on an idealized profile with a distinct heel. As many of the profiles in Ventura County have no distinct heel, the landward extent of splashdown was evaluated by first calculating the trajectory of the overtopping jet with the vertical and landward velocities as

$$Y = (V_C \cos \alpha) t$$

$$Z = (V_C \sin \alpha) t - \frac{1}{2} g t^2 \quad (4.6-1)$$

where  $Y$  and  $Z$  are the cross-shore positions and elevations respectively of the jet,  $V_C$  is the velocity component, and  $t$  is time. It is important to note that these equations are the basis of the splash overtopping analysis and Figure D.4.5-15. They are also the same equations that Dr. Bill McDougal used in developing a general solution for the splashdown extent (DOGAMI 2012).  $Y_{G,Outer}$  was then found numerically as the intersection of the trajectory and the profile (Figure 19).

6. Calculate the total energy,  $E$ , of the splashdown:  $E = \Delta R - z_G$ , where both variables are relative to the barrier crest elevation.

$$z_G = -0.55 \text{ ft}$$

$$E = 2.860835$$

7. Calculate the initial splashdown  $V_o$  and  $h_o$  according to:  $V_o = 1.1\sqrt{gE}$  and

A correction to the calculation of the initial splashdown height,  $h_o$ , was applied as follows:  $h_o = 0.38E$  where  $E = \Delta R - z_G$  (revision to Step 7 on Page D.4.5-30 of the *Pacific Guidelines*, which incorrectly defined the initial splashdown height as  $h_o = 0.19E$ ). The C-M method will be used in the floodplain

$$V_o = 10.55338 \text{ ft/sec}$$

$$h_o = 1.087117 \text{ ft}$$

$$\text{2nd VE El} = 17.5 \text{ ft} \quad \text{RESULT "2nd VE Zone BFE"}$$

8. Calculate the landward limit of  $hV^2 = 200 \text{ ft}^3/\text{sec}^2$ , where  $h$  is the water depth given by the Cox-Machemehl method (discussed below) and  $V$  is considered to be uniform, i.e.,  $V = V_o$ .

C-M Equation was initially solved for the landward extent of the VE Zone ( $Y$ ) where  $hV^2 = 200 \text{ ft}^3/\text{sec}^2$

$$h(y) = \left[ \sqrt{h_o} - \frac{5(y-y_o)}{A_m \sqrt{gT^2}} \right]^2$$

$$hV^2 = 200 \text{ ft}^3/\text{sec}^2$$

$$h = 1.8 \text{ ft} \quad \text{RESULT "AO Zone Depth"}$$

$$(y-y_o) = -4.438739 \text{ ft}$$

$$Y_g+(y-y_o) = 1.108141 \text{ ft} \quad \text{RESULT "Y"}$$

		Trajectory		Plot	
7621.30	12.55	0.00	0	7632.453	17.00979
7624.25	14.50	3.28	0.363853895	7635.734	17.05365
7629.17	15.94	4.55	0.244495505	7637	16.80309
7632.45	17.01	5.55	0.047964659	7638	16.50292
7635.73	16.69	6.56	-0.24371163	7639.015	16.10609
7637.00	16.56	9.84	-1.822696574	7642.296	13.47712
7638.00	16.45	13.45	-4.681569442	7645.904	9.178262
7639.01	16.35	17.01	-7.5546389	7708.24	-223.065
7642.30	15.30	17.01	-8.891	7721.363	-316.677
7645.90	13.86	16.81	-9.285	7725.3	-348.148
7708.24	16.49	16.93	-9.646	7728.909	-377.921
7721.36	17.01	17.02			
7725.30	16.81	17.02			
7728.91	16.93	17.02			
7737.11	17.02	17.02			
7742.03	16.61	17.02			
7745.97	16.81	17.02			
7749.91	16.82	17.02			
7753.19	16.94	17.02			
7756.47	16.96	17.02			
7760.08	17.08	17.02			
7763.36	17.14	17.02			
7766.64	17.22	17.02			
7770.25	17.26	17.02			
7776.15	17.37	17.02			
7779.76	17.58	17.02			
7784.35	17.57	17.02			
7788.62	17.60	17.02			
7792.23	17.68	17.02			
7796.82	17.75	17.02			
7805.02	17.76	17.02			
7808.96	17.79	17.02			
7813.23	17.73	17.02			
7816.83	17.60	17.02			
7820.11	17.53	17.02			
7823.72	17.49	17.02			

The equation was subsequently solved for the landward extent of the AO Zone ( $Y_0$ ) where  $hV^2 = 0 \text{ ft}^3/\text{sec}^2$ .

$$hV^2 = 0 \text{ ft}^3/\text{sec}^2$$

h	=	0 ft		
(y-y <sub>0</sub> )	=	15.56125 ft		
Y <sub>g</sub> +(y-y <sub>0</sub> )	=	<table border="1"><tr><td>21.10813 ft</td><td><i>RESULT "Y<sub>0</sub>"</i></td></tr></table>	21.10813 ft	<i>RESULT "Y<sub>0</sub>"</i>
21.10813 ft	<i>RESULT "Y<sub>0</sub>"</i>			