Appendix A—Engineering Input

USACE

New Orleans District (CEMVN)

Morganza to the Gulf (MTG)

CEMVN Engineering Division Input to the 2021 Engineering Documentation Report

October 2021

Prepared By

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In Coordination with

Terrebonne Levee and Conservation District (TLCD)
Coastal Restoration and Protection Authority Board of Louisiana(CPRAB)
North Lafourche Levee District (NLLD)
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List of Acronyms
ACB - Articulated Concrete Block
ACA – Adaptive Criteria Assessment
AEP – Annual Exceedance Probability
CEMVN – USACE New Orleans District
CPRAB – Coastal Protection and Restoration Authority Board of Louisiana
CPT – Cone Penetrometer Test
CSU - Colorado State University
E&D – Engineering and Design
FOS – Factor of Safety
FPEIS - Final Programmatic MTG EIS
GIWW – Gulf Intercoastal Waterway
HNC – Houma Navigation Canal
HPTRM - High Performance Turf Reinforcement Mat
HSDRRS – Hurricane and Storm Damage Risk Reduction System
HQUSACE- Headquarter USACE
LAMP -Levee Analysis Mapping Process
LORR – Level of Risk Reduction
LSP – Levee Safety Program
LWL - Low Water Level
MTG – Morganza to the Gulf
NAVD – North American Vertical Datum
NLLD – North Lafourche Levee District
NFS – non-Federal Sponsor
OMRR&R - Operation, Maintenance, Repair, Rehabilitation and Replacement
PACR – Post Authorization Change Report
PED – Preconstruction Engineering and Design
PDT - Project Delivery Team
RMC – Risk Management Center
S&A – Supervision and Administration
SLLD – South Lafourche Levee District
SWL - Still Water Level
TLCD – Terrebonne Levee and Conservation District
TOW - Top of Wall
TPC - Total Project Cost
TRM – Turf Reinforcement Mat
USFWS – US Fish & Wildlife Service
WIFIA - Water Infrastructure Finance and Innovation Act
WOS - Wave Overtopping Simulator
WRDA – Water Resources Development Act
WRRDA – Water Resources Reform and Development Act

1.0 INTRODUCTION & BACKGROUND

The Morganza to the Gulf (MTG) hurricane and storm damage risk reduction project is predominantly situated in Terrebonne Parish and partially in Lafourche Parish. It consists of a southern Louisiana levee alignment approximately 98 miles long, including associated navigation, roadway, pump station fronting protection, and environmental structures. MTG was authorized by the Water Resources Development Act (WRDA) of 2007 at a cost of $886,700,000. However, due to the implementation of the Hurricane and Storm Damage Risk Reduction System (HSDRRS) design criteria following the devastating impacts of Hurricane Katrina on the New Orleans metropolitan area, the MTG project was redesigned based on updated hydraulic modeling and to the new HSDRRS design criteria. Resulting costs exceeded the 20 percent cost increase limit specified in WRDA 1986, Section 902.

Subsequently, a Post Authorization Change Report (PACR) was completed in 2013 seeking Congressional re-authorization of the MTG construction and operation, maintenance, repair, rehabilitation, and replacement (OMRR&R). The PACR was successfully completed and subsequently served as the basis for the Congressional re-authorization of the MTG project in the Water Resources Reform and Development Act (WRRDA) of 2014, at an estimated cost of $10.3B. Major changes to the project features included increasing the total levee length from 72 miles to 98 miles, increasing levee/structure elevations and levee widths, increasing the number of floodgates and environmental control structures from 9 to 19 and 12 to 23, respectively, increasing the sill depth and floodgate width for the Houma Navigation Canal (HNC) lock complex, and including costs for mitigation to address potential indirect impacts. Additionally, one of the two Gulf Intercoastal Waterway (GIWW) sector gates near Houma was eliminated. However, due to the resulting significant increase in project cost, MTG has only received limited Federally funding to date for construction and is unlikely to receive significant funding by OMB for construction at the PACR cost level moving forward.

Prior to the authorization of the project by WRDA 2007 and continuing after its re-authorization in WRRDA 2014, Terrebonne Levee and Conservation District (TLCD) and other non-Federal entities independently constructed elements on the authorized MTG alignment and features utilizing local funding.To date, TLCD has designed and constructed approximately 47 miles on the authorized levee alignment to an elevation of 12 feet (NAVD88, epoch 2004.65) (existing elevations range from 10.0 to 11.5 feet due to settlement) as well as a total of 23 structures in the alignment consisting of barge floodgates, environmental structures, and pump station fronting protection. Agreements were not in place prior to construction and the TLCD is not eligible for in-kind credit for the work that was performed prior to the signing on an in-kind Memorandum of Understanding (MOU) effective December 4, 2019. In-kind construction that was initiated pursuant to the in-kind MOU its effective date, or that is constructed under the anticipated Project Partnership Agreement, may be eligible to be considered for credit. The HNC Lock Complex is also set to begin construction in 2021.

In 2013 the Risk Management Center (RMC) and the U.S. Army Corps of Engineers (USACE) New Orleans District (CEMVN) completed the Issue Evaluation Study for Design Criteria Site-Adaptation Report for the Proposed MTG Levee System. The preliminary findings of this Report, are referenced in the 08 July 2013 Chief of Engineers Report, that recommends adaptive criteria for the project "to reduce project cost without significantly increasing risk." In March 2019, in coordination with TLCD, North Lafourche Levee District (NLLD), South Lafourche Levee District (SLLD) and Coastal Protection and Restoration Authority Board of Louisiana (CPRAB), an Adaptive Criteria Assessment Report (ACAR) was completed for the MTG project. The primary objective of the ACAR effort was to capitalize on the Non-Federal Sponsor (NFS) investment to date (considering actual cost data and available borrow locations as well as improved foundation strengths) to optimize designs, resulting in a lower cost of constructing the remaining alignment to a fundable level. This ACAR resulted from a tasker from a 14 Nov 2018 meeting with Rep. Graves, CPRAB, Stakeholders, HQUSACE, CEMVD, and CEMVN, where CEMVN was directed by HQUSACE to perform an assessment in collaboration with local stakeholders. Adaptive criteria would be utilized in conjunction with actual material costs for local constructed components, where appropriate. The effort took 6 months (from the 14 Nov 2018 meeting) to produce a technical report with potential cost-saving findings while retaining the 1% AEP or 100-year, consistent with the PACR. Note the ACAR was a limited investigation into potential cost savings and due to the limited time, scope, and funding, did not include economic analysis or any discussion on project credits, benefits, specific cost-sharing, or OMRR&R costs. The ACAR was completed in 2019, and the tenets have been supported by CEMVD, HQUSACE, and the Assistant Secretary of the Army—Civil Works (ASA(CW)). In Fiscal Year 2020, reprogramming actions were received in the amount of $1.25M in investigation funds to perform an Economic Update and development of plans and specifications for the Humble Canal preload contract. All of the aforementioned actions have lead to the current design, that is described in this report.

A step forward toward progressing the design of MTG and providing documentation for the Engineering Documentation Report (EDR) is to obtain a certified cost estimate. Hence, CEMVN has developed formal MII cost estimates with updated quantities, design, and cost data for the 2035 and 2085 project horizons. This report serves as the technical explanation for the current design that is described in the present EDR and the change in costs from the 2013 PACR to the current design utilizing adaptive criteria. The newly developed MII estimates and corresponding risk register and Crystal Ball output have been developed by CEMVN and submitted to the USACE Cost Center of Expertise for review and cost estimate certification.

2.0 REFERENCES

a. U.S. Army Corps of Engineers, Morganza, Louisiana, to the Gulf of Mexico, Mississippi River and Tributaries (Chief of Engineers Report), August 2002.

b. U.S. Army Corps of Engineers, Morganza, Louisiana, to the Gulf of Mexico, Mississippi River and Tributaries Supplemental Report (Chief of Engineers Report), July 2003.

c. U.S. Army Corps of Engineers, New Orleans District Engineering Division, Hurricane and Storm Damage Risk Reduction System Design Guidelines (Interim), October 2007 (Includes 12 June 2008 Revisions).

d. U.S. Army Corps of Engineers, Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report, August 2009.

e. U.S. Army Corps of Engineers, New Orleans District Engineering Division, Hurricane and Storm Damage Risk Reduction System Design Guidelines, New Orleans District Engineering Division, February 2011.

f. U.S. Army Corps of Engineers, Post Authorization Change Report, Morganza to the Gulf of Mexico Project, LA, May 2013.

g. U.S. Army Corps of Engineers, Morganza, Louisiana, to the Gulf of Mexico, Mississippi River and Tributaries (Chief of Engineers Report), July 8, 2013.

h. U.S. Army Corps of Engineers, Risk Management Center, Issue Evaluation Study, Design Criteria Site-Adaptation Report for the Proposed Morganza to the Gulf Levee System, July 24, 2013, which includes as an Appendix the Morganza to the Gulf Sensitivity Analysis from October 2012.

i. Morganza to the Gulf Cost Assessment, November 2018.

j. Adaptive Criteria Assessment Report (ACAR) transmittal to CEMVD inclusive of review comments and transmittal correspondence between CEMVN, CEMVD, and HQ, CEMVN, May 2020.

Reports cited are incorporated by reference.

3.0 SYSTEM DESCRIPTION

The authorized MR&T MTG project is designed to provide hurricane and storm damage risk reduction benefits to a 1% AEP (or 100-year) (otherwise known as 1% or 100-year LORR) while ensuring navigational passage and tidal exchange. MTG is located in the state of Louisiana, about 60 miles southwest of New Orleans, and includes Terrebonne Parish and the portion of Lafourche Parish between the eastern boundary of Terrebonne Parish and Bayou Lafourche. The study area extends south to the saline marshes bordering the Gulf of Mexico and encompasses approximately 1,900 square miles. The GIWW and the HNC are major waterways in the area. The GIWW passes through Houma in an east-west direction. The HNC extends due south from Houma to the Gulf of Mexico. Bayou Lafourche runs along the northeastern boundary of the project/study area. Figure 3-1 illustrates the currently authorized MTG levee alignment (in red) relative to New Orleans and other towns/landmarks as well as water bodies in the Southeast Louisiana vicinity. The authorized MTG levee alignment primarily follows existing hydrologic barriers, such as natural ridges, roads, and existing local levees.

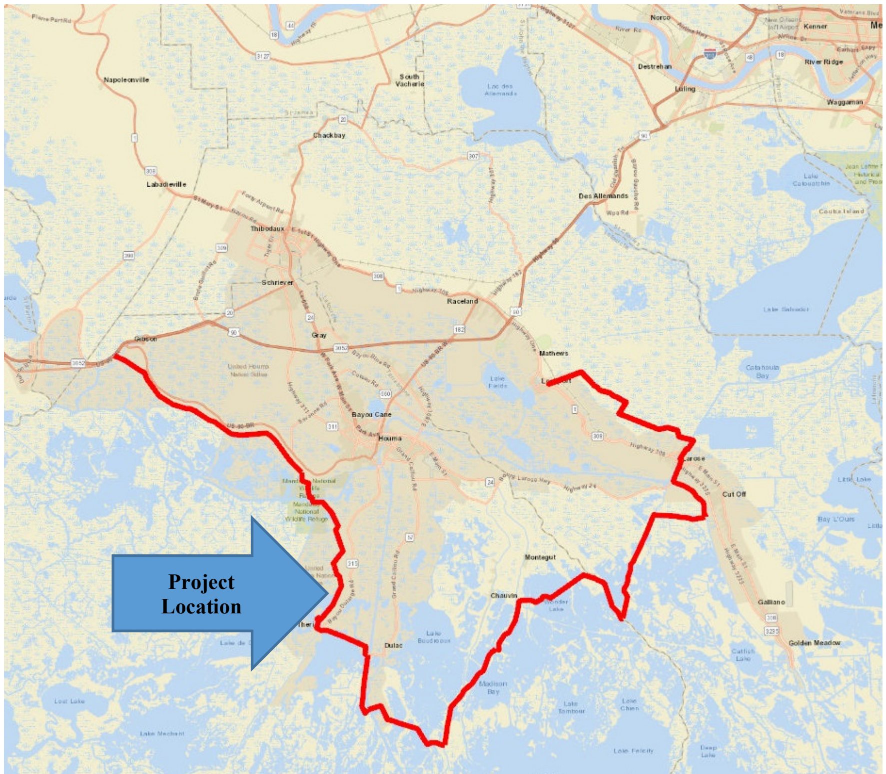


Figure 3-1 Vicinity Map

Figure 3-2 illustrates the status of construction as of January 2021. Green highlighted alignments have been constructed by local stakeholders to an elevation of 12.0 feet (with corresponding settlement throughout the alignment that has resulted in current elevations ranging from 10.0 to 11.5 feet). Yellow highlighted reaches are currently under construction by local stakeholder. Red highlighted reaches have no construction activities to date.

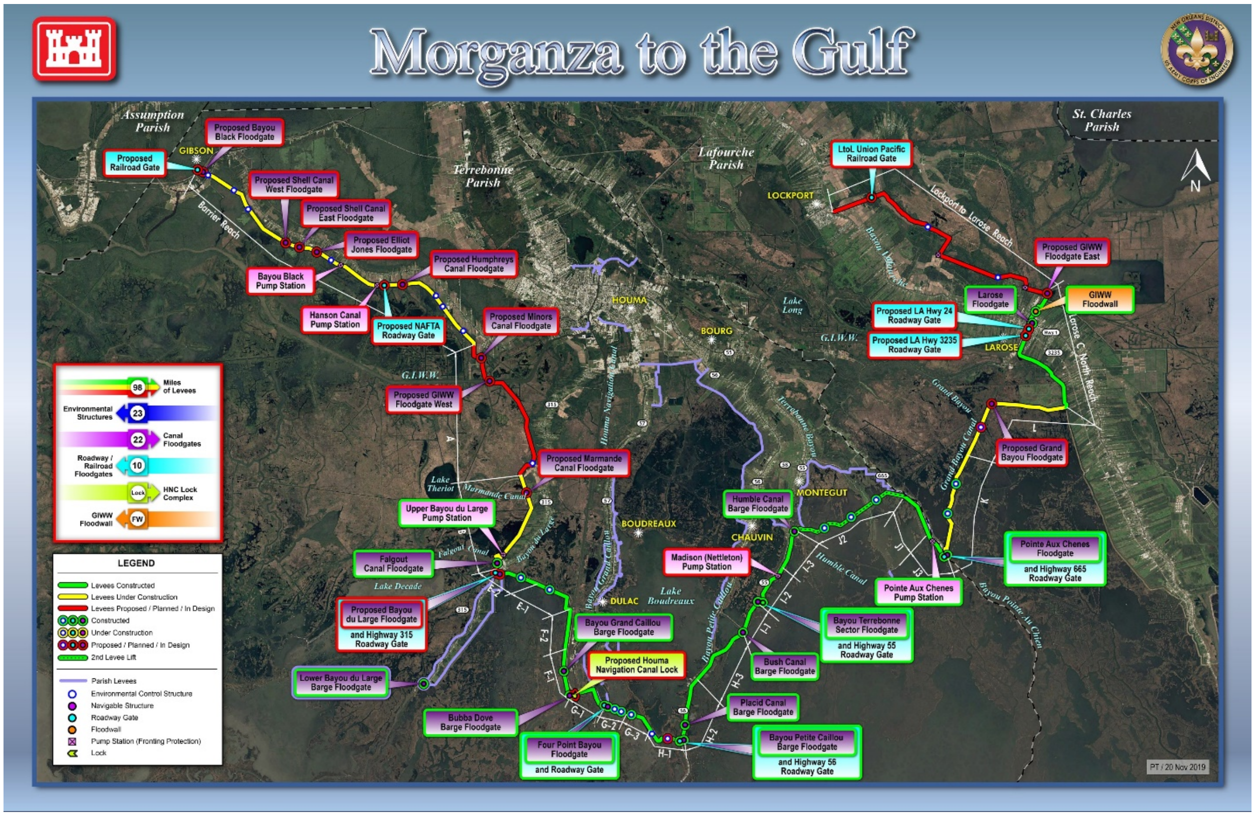


Figure 3-2 – MTG Levee Alignment (See Appendix A for larger version)

There are a total of approximately 98 miles of earthen levee, 22 hurricane and storm damage risk reduction structures on navigable waterways (includes 1 at GIWW and 2 "Bubba Dove" at HNC), 10 roadway/railroad gates, 23 environmental structures, fronting protection for pump stations, and the HNC Lock Complex in the currently authorized alignment. To date, approximately 47 miles of earthen levee have been constructed by local interests to an elevation of 12 feet (**NAVD88 epoch 2004.65 – all elevations throughout this document are referenced to this datum**). Due to settlement, existing elevations range from 10.0 to 11.5 feet throughout local stakeholder constructed alignments (based on stakeholder provided data). The locally-funded HNC Lock Complex is scheduled to begin construction in 2021.

4.0 SUMMARY OF PAST REPORTS/ANALYSIS

4.1 PACR

The PACR report for MTG was completed in 2013. The 2013 PACR estimated cost of the project was approximately \$10.3B (w/contingencies), resulting in over \$9B of cost increase as compared to the originally authorized project. In addition to the adoption of the HSDRRS criteria, the cost increase is predominantly attributable to updated hydraulic modeling, which utilized state-of-the art hydraulic modeling methodologies as well as updated geometry (bathymetry and LIDAR) to compute new 1% hydraulic elevation requirements. MTG was subsequently re-authorized, however, the project has not been funded for construction to date and is unlikely to be funded for construction at the PACR cost level moving forward.

4.2 RMC HISTORICAL EFFORTS

In 2013 the Risk Management Center (RMC) and CEMVN completed the Issue Evaluation Study for Design Criteria Site-Adaptation Report for the Proposed MTG Levee System. The preliminary findings of this Report, are referenced in the 08 July 2013 Chief of Engineers Report, (paragraph 7), and states, "While the estimated project costs in the district's report are the best available and compliant with current post-Katrina design criteria, the U.S. Army Corps of Engineers Risk Management Center and the New Orleans District jointly evaluated the proposed MTG project to assess whether the post-Katrina design criteria, specifically in the areas of global stability, overtopping, and structural superiority, could be site adapted to reduce project cost without significantly increasing risk. Based on the results of this effort, site adaptations of the criteria were identified for consideration during the next phase of implementation, preconstruction, engineering and design." Part of that report (in an Appendix) included performing a Sensitivity Analysis (conducted in 2012) on one reach (J-2) of the proposed MTG alignment to investigate potential cost savings. The RMC report served as the original basis for the MTG ACAR.

Under the "Major Findings and Understandings" section on page 73 of the RMC Issue Evaluation Study, the three primary design parameters recommended for adjustment include increasing the allowable overtopping rate to 0.5 cfs/ft (0.1 cfs/ft required for HSDRRS criteria), lowering the allowable factor of safety for global stability from 1.5 to 1.3, and eliminating structural superiority. Specifically, the recommendations are quoted as follows:

"1. Reduce the Factor of Safety (FoS) for end of construction global stability from 1.5 to 1.3. The risk assessment team concluded that there is inconsequential change in post-project residual risk for a levee 800 ft wide (associated with global stability FoS = 1.5) versus a 600 ft wide (associated with a global stability FoS = 1.3). This reduction in end of construction factor of safety does increase the likelihood of slope stability failures during construction, which is often unacceptable in an urban environment. However, for the non-urban setting of this project, slope stability failures during construction can be mitigated during construction at relatively low costs and are unlikely to cause loss of life or significant property damage.

2. Change the Design Overtopping Rate for well-maintained grass-covered levee slopes from 0.1 to 0.5 cfs/ft. This change could result in reduction of levee and structure elevations by several feet. Based on tests conducted to assess USACE HSDRRS designs, the grass cover on clay levee slopes are generally not expected to fail at average overtopping rates of less than 1 cfs/ft.

3. Elimination of the structural superiority requirement. Reducing top elevations of structures to match adjacent levee heights would lead to significantly shorter structures, i.e., reducing structure elevations by 2 ft in addition to the reductions in elevation resulting in the change in design overtopping rate." (Note, As defined in the HSDRRS Design Guidelines on page 5-2 under Section 5.1.3, structural superiority is 2 feet added to structure elevations above the required design grade of adjacent levee alignments. Intent of structural superiority is to provide additional elevation for difficult to construct features such as sector gates, utility crossing, etc., in an effort to minimize the need for future adjustment should design grades increase due to greater than expected subsidence or sea level rise. In addition, structure superiority lowers the potential for overtopping at critical infrastructure)."

4.3 ADAPTIVE CRITERIA ASSESSMENT REPORT (ACAR)

Beginning in November 2018, CEMVN was tasked to investigate further the "site adaptations of the criteria (that) were identified for consideration during the next phase of implementation, preconstruction, engineering, and design" from the 8 July 2013 Chiefs Report. Using the RMC report criteria along with detailed information from local stakeholders, the team would evaluate any potential cost savings for the project. This refined design approach was applied to the proposed MTG alignment to determine an updated cost. In addition, the levee material quantities and costs were updated to consider the levees constructed by local interests. Another cost savings component is based upon the Non-Federal Sponsor proposal to limit the federal investment for a 1% AEP to the year 2035 project horizon, where the local stakeholders would be responsible, at 100 percent non-Federal cost, to construct levee lifts, demolition and/or reconstruction of structure alterations of floodgates to achieve hydraulic design levels, and any other modifications to the Project following completion of Federal/non-Federal Sponsor Cost Shared Work (to attain the 1% AEP to the year 2035 project horizon), or functional portion thereof, through the end of the project period of analysis (currently estimated to extend to the calendar year 2085) as necessary to maintain the 100-year level of risk reduction for the Project. This 4-6-month assessment was limited in scope, but the team was able to gain more certainty in the applicability of the "site adaptations." Investigation Funds were received in Fiscal Year 2020 to further develop the design and to update the costs and benefits. **This report documents the current design and the basis of quantities and costs for the newly developed CEMVN-ED MII cost estimates and input to economic analysis in the EDR.** MTG received "Construction New Start" funds from the Fiscal Year 2021 Work Plan for the Army Civil Works program on 19 January 2021 to commence construction of the project.

5.0 APPROACH

Primarily, efforts are focused on the effect of the site adaptations on the levee cross-section and footprint to update assumptions that will constitute the current design of the project. The design of the MTG project has evolved since completion of the PACR. The design described in this report is a "snapshot" of the current design, further developing the tenets of the ACAR and other updates based on new information. When approaching the focus of design update, it was noted that the levee construction constitutes approximately 50% of the Total Project Cost (TPC). Reductions or changes in levee quantities generate a corresponding "ripple" effect to other projects' costs. Parameters such as mitigation and real estate will also see cost savings as the levee sections and footprints are reduced. As costs of construction features are reduced, cost for Supervision and Administration (S&A), Engineering and Design (E&D), and contingency are likewise reduced as these parameters are typically a percentage of construction costs.

In summary, cost saving measures implemented consist of:

- Updated hydraulic modeling that capitalizes in advancement of modeling technologies since completion of the PACR
- Lower design elevation requirements developed while maintaining a 1% LORR and 0.5 cft/ft overtopping rate with 2 feet of overbuild for settlement

- Levee global stability Factor of Safety (FoS) of 1.3 instead of 1.5
- Geotechnical analysis to investigate foundation strength gains through soil consolidation of the existing levees
- New Cone Penetrometer Test (CPT) data (Increased strength gains enable levees to be constructed higher with minimal increase in footprint size, thereby saving cost in material placement for the 47 miles of locally constructed levee.)
- Tailoring haul distances to align with stakeholder input on actual pits used to date
- Tailoring haul distances to align with potential stakeholder identified pit locations which they have identified since PACR completion
- Subtracting quantities of levee material placed to date from revised design sections
- Re-assessing structures to develop new quantities based on revised hydraulic design elevations and conversion of the PACR sector gates to barge gates (except for two GIWW gates which shall remain sector gates)
- Obtaining updated costs for fabricated steel tailored to barge gates for current hydraulic elevations
- Eliminating structural superiority requirements

6.0 ENGINEERING DISCIPLINE INPUT

6.1 HYDRAULICS

CEMVN developed new hydraulic levee sections based on updated hydraulic models that capitalize on new modeling methods and techniques developed since completion of the 2013 PACR as well as the 2019 ACAR. The following table summarizes changes/improvements in the hydraulic modeling resulting in the lower hydraulic design elevations from the 2013 PACR.

Design Parameter	Design Updates	Notes
Coupled ADCIRC + SWAN model storm surge characteristics	New storm surge characteristics from the updated coupled model were used to develop stage frequency curves, fragility curves, levee design elevations, and structure design elevations.	Stage frequency curves, fragility curves, levee designs and structure design elevations are lower than the elevations presented in the PACR. The extreme return events stillwater elevations are lower and the more frequent return events are higher.
Overtopping equations	Van der Meer overtopping equations changed to EurOtop overtopping equations for use in computing levee design elevations.	Implementation of the EurOtop equation resulted in a change in levee height of approximately 0.50 feet lower than van der Meer. The ½ foot variation is within the uncertainty band of the model (+/-0.50 feet) and could vary based on the use of a different surge model result output point.
Overtopping threshold rate	Overtopping threshold rate increased from 0.1cfs/ft to 0.5cfs/ft	Overtopping threshold rate of 0.5cfs/ft approved from the post PACR RMC site adaptation report was used for levee designs

		and corresponding structure design elevations which resulted in lower design elevations.
Removal of wave berm design option	A berm factor was not incorporated in the levee design equations.	In the PACR, levee elevations for a few construction reaches were determined with and without wave berms. In this update wave berms were not used, resulting in higher elevations but smaller footprints than levees designed with- wave berms.

In addition to the updates noted in the table above, the existing conditions hydraulic modeling was updated using the 2017 Coastal Protection and Restoration Authority's (CPRA) 2017 Master Plan ADCIRC mesh. The 2017 CPRA ADCIRC mesh was developed to represent base conditions for the 2017 State Master Plan. The 2017 Master Plan ADCIRC mesh is a heavily validated and verified ADCIRC mesh which performs well for hindcasts of Katrina, Rita, Gustav, Ike, and Isaac.

Appendix D provides the methodology, detailed explanations, figures, and corresponding tabular results for the hydraulic engineering re-analysis performed for the updated design. Structural elevations are the same for the without wave berm conditions and are therefore not tabulated separately. The table below summarizes the new hydraulic design elevation results compared to the 2013 PACR results illustrating the elevation differences (lower), which directly corresponds to lower costs in the design of alignment features.

Hydraulic Reach*	Current Design 1% Design Elevations		PACR 1% Design Elevations**	
	(NAVD88 epoch 2004.65)			
	2035***	2085	2035	2085
A	-	-	15.5	20.5
A-North of GIWW	10.0	16.5	15.5	20.5
A-South of GIWW	11.0	16.5	-	-
B	13.0	18.5	17.5	20.5
E2	17.5	21.0	21.5	23.5
E1	17.0	20.0	21.5	23.5
F2	16.0	19.0	22.0	23.5
F1	15.5	18.5	22.0	23.5
G1	17.0	19.5	22.5	24.0
G2	17.5	20.5	22.5	24.0
G3	18.0	20.5	22.5	24.0
H1	17.0	20.0	24.0	26.5
H2	18.0	22.0	24.0	26.5
H3	20.0	24.0	24.0	26.5
I1	20.0	24.0	24.0	26.5
I2	21.0	25.0	24.0	26.5
I3	20.0	24.5	24.0	26.5
J2	21.5	25.0	24.0	26.5
J1	20.5	24.0	24.0	26.5
J3	20.0	23.5	24.0	26.5

K****	20.5	26.0	22.5	25.5
L	20.5	24.5	22.5	25.5
Larose C-North	-	-	18.0	20.5
C-North	8.5	16.5	-	-
GIWW	8.5	15.5	-	-
Lockport to LaRose	-	-	10.5	15.0
Lockport to LaRose-A	9.5	13.0	-	-
Lockport to LaRose-B	7.5	11.0	-	-
Barrier	10.5	17.0	15.5	20.0

*Hydraulic reaches were subdivided into segments as shown on reach map. PACR A is also referred to as A-North of GIWW and A-South of GIWW. PACR Larose C-North is C-North and GIWW and PACR Lockport to Larose is Lockport to Larose A and B.

**PACR levees were designed with wave berms; current design has no wave berms.
*** Does not include 2.0 feet of overbuild.
**** R**each K elevation is a ½ higher than in the PACR report. The slight variation may be due to higher stages on the exterior than in the PACR models, removal of wave berm or some other unknown anomaly**

6.2 GEOTECHNICAL

With CEMVN hydraulic analysis complete, CEMVN geotechnical engineers developed new design sections for Reaches J2, B, Barrier Reach, and Reach F for the 1% LORR. The analysis was completed on four representative design sections. Additionally, a section developed by CPRAB for Reach E was evaluated. Section 6.2.4 includes further discussion on the design sections completed. The geotechnical engineers then performed an assessment of how to apply the design sections to the remaining reaches (i.e., which sections best fit the remaining un-designed reaches). Civil Engineers subsequently developed quantities throughout the alignment by using the newly designed sections and geotechnical engineering guidance to match analyzed cross-sections to similar reaches. See Appendix C for the tabular calculation of new levee quantities.

As stated above, CEMVN reviewed design sections developed by CPRAB for Reach E. TLCD furnished levee section data, including construction plans and specifications for various MTG levee reaches constructed to date. Additionally, the TLCD provided geotechnical reports, boring/CPT logs, and soil parameters for each design Reach. Reaches E and G were constructed with geotextile fabric reinforcement. Otherwise, TLCD only utilized fabric adjacent to structures in the remaining reaches. The CPRAB design section has been applied to Reaches E and G only.

6.2.1 NEW CPT DATA POINTS

MTG soil data obtained by CEMVN was collected before the TLCD began levee construction. Since the first stage of levee construction for some of the levee reaches have already been constructed, consolidation and strength gain of foundation soils have taken place. CEMVN and the CPRAB performed theoretical foundation strength gain calculations. The TLCD collected 10 new CPT data points during the ACAR to assess validity of the strength gains assumed in CPRAB and CEMVN geotechnical analyses. Two CPTs per reach were collected adjacent to existing soil borings or CPTs performed for previous CEMVN studies/investigations prior to levee construction in reaches J2, H, F, E, and Larose C North. The CPT data validated the methodology used to estimate the strength increase in foundation soils. The CPTs are considered representative of subsurface conditions at the CPT locations on the date completed.

6.2.2 GEOTECHNICAL DESIGN METHODOLOGY AND ASSUMPTIONS

TLCD has either completed construction or has begun construction on reaches B, E, F, G, H, J, K, and L to initial elevations of approximately 12 feet. Subsequent settlement of these reaches range from 0.5 feet to 1.5 feet over approximately two years. Because large amounts of settlement were observed and predicted during the first two years after levee construction, strength gain of foundation soils was incorporated into the design of future material placement on the existing reaches. Only gains in strength occurring during the initial two years after levee construction were considered. Geotechnical engineers developed the initial effective overburden for a reach with no levee present and then determined the levee section from the TLCD's P&S that was likely constructed. Using Rocscience's Settle3D software, geotechnical engineers modeled this section to determine the induced stress with depth resulting from the constructed section at a time stage of two years. All design and construction data provided by the TLCD can be found in the MVN Projectwise system at the following address: pw:\\PWINT-CPC.EIS.DS.USACE.ARMY.MIL:CEMVN01\Documents\Civil Works\M2G - Morganza to the Gulf\Work By Sponsors\Structures\.

The geotechnical engineers found that cohesive soils in southeastern Louisiana typically have an undrained shear strength to vertical effective stress ratio equal to approximately 0.22. Therefore, the engineers multiplied the induced change in stress at approximately two years by the correlation factor of 0.22 to estimate the increase in shear strength gain at the centerline and toe of the existing levee.

Geotechnical engineers then applied these strength gain values to slope stability using the 2016 version of GeoStudio's Slope/W program to perform slope stability analyses using the Spencer's Method for Still Water Level (SWL), Low Water Level (LWL), and Top of Wall (TOW) water loadings. The required global stability factor of safety is 1.3 for SWL and LWL. Geotechnical engineers assumed that additional shear strength gains in the soft clay soils encountered throughout the project would improve the global stability factor of safety during levee construction to the 2nd stage. A global stability FOS of 1.2 was utilized to capture foundation strength gains of soft soils during initial levee construction in our geotechnical analyses for all reaches analyzed. Additionally, for levee reaches where the first lift has already been constructed, foundation strength gains will continue to increase. Only strength gains from two years of consolidation are accounted for in our analyses. However, additional strength gain will be realized before construction to the 2nd levee lift. Typically, foundation strength gains are not considered for levee enlargement of existing levees. However, the timing between levee lifts, the large size of the typical enlargement, and additional foundation consolidation and strength gains justify this approach. Therefore, the factor of safety was designed to 1.2 for this assessment. After construction of these lifts, a field investigation program will be developed to document and verify foundation strength gains have occurred, and a FOS of 1.3 was obtained.

The cross-section for cost estimation for Reach E was provided to USACE by CPRAB. CEMVN openly shared design methodologies with CPRAB to ensure consistency in design and engineering analyses.

In addition to slope stability analyses, geotechnical engineers analyzed reaches J2, F, B, and the Barrier Reach for settlement using Settle3D. Each reach was designed with a two-foot overbuild to account for settlement after construction. With this two-foot overbuild, each of the levee crowns analyzed remained above the 1% design elevation for at least seven years.

Geotechnical engineers considered a levee cross-section with and without a wave berm as designed by hydraulic engineers. After preliminary analyses, the "without wave berm" case was decided to be the smaller, more cost-effective levee section required for stability. The large wave berm developed by hydraulic engineers was not necessary for stability, particularly for the low water case. Therefore, quantity calculations made in the current analyses were performed for the "without wave berm" case.

6.2.3 SEEPAGE

Seepage analyses were not performed. Nevertheless, based on geotechnical engineering experience, the difference in cross-section between the currently proposed cross-section and the cross-sections previously developed for the PACR do not significantly impact seepage performance under a flood load due to a reduced levee crown height for the current analysis and the similar foundation conditions. In the PACR, seepage analyses were analyzed for the foundation of reach F and reach I and indicated satisfactory seepage FOS for SWL and Top of Levee (TOL). Reach F is believed to be the most vulnerable to seepage due to the presence of near surface sands and will represent a worst-case seepage condition for the western portion of the project. Reach I represents a typical eastern reach in regards to seepage. Additionally, borrow pits constructed to provide side cast material for future levee construction will be designed to be far enough away from the levee to ensure an adequate seepage FOS.

6.2.4 CONSTRUCTION METHODOLOGY ASSUMPTIONS

Since USACE was not involved during initial non-Federal levee construction along the MTG alignment, geotechnical engineers assumed quality control testing such as soil classification, moisture content, organic content, and sand content were performed to ensure proper embankment material was used for construction. Embankment materials should be classified in accordance with ASTM D 2487 as CL or CH with less than 35% sand content. Geotechnical engineers assume typical embankment construction methods, including clearing, grubbing, and proper drainage, were performed. CEMVN understands that the first lift primarily served to preload the foundation of the levees and that minimal compaction effort took place (i.e., three passes of a dozer). As such, soil properties included in the analyses assumed semi-compacted levee fill with a unit weight of 110 pcf and cohesion of 400 psf. To account for settlement of foundation soils, geotechnical engineers designed each levee Reach with a two-foot overbuild of the levee crown. Per information provided by the TLCD, the first lifts of reaches E and G were constructed with geotextile reinforcement. All other levee reaches constructed to date do not have geotextile reinforcement fabric in the section.

Levee cross-sections were designed and analyzed for slope stability and settlement for reaches J-2, B, F, E, and the Barrier Reach. The 1% design elevation for MTG levees varies across reaches from elevation (EL) 7.5 to EL 21.5 for 2035 and EL 11 to 26 for 2085. The reaches that the geotechnical engineers analyzed represent good coverage with respect to varying levee crown elevations as they apply to engineering analyses. Therefore, appropriate levee cross-sections that CEMVN analyzed were applied to MTG Reaches that were not analyzed. Projection of design sections were assumed as follows: Reach J2 was projected to reaches H2, H3, I1, I2, I3, J1, K, and L; reach B was projected to reach A; reach E was projected to reach G; the Barrier Reach was projected to the Lockport to Larose Reach, and reach F was not projected onto any other reach.

In summary, the geotechnical engineers provided civil engineers (1) four new design sections, (2) CPRAB's reach E design section, and (3) instructions on how to apply the new design sections to the remaining reaches throughout the alignment. Design sections developed utilizing the adaptive criteria for the without wave berm condition are illustrated in Figures 6-1 thru 6-5.

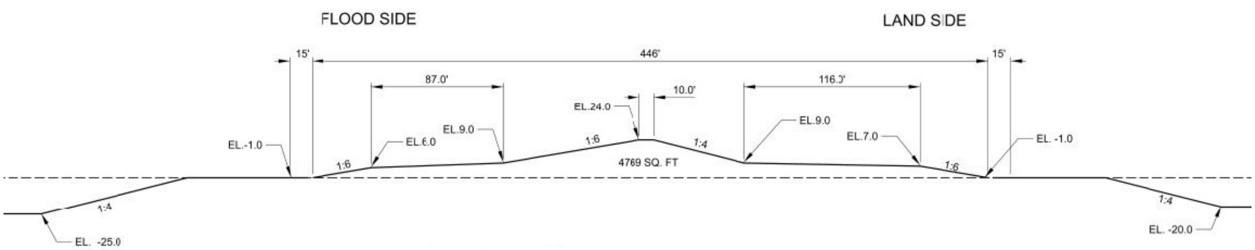


Figure 6-1 - Typical Section Reach J-2 – Not to Scale (NTS)

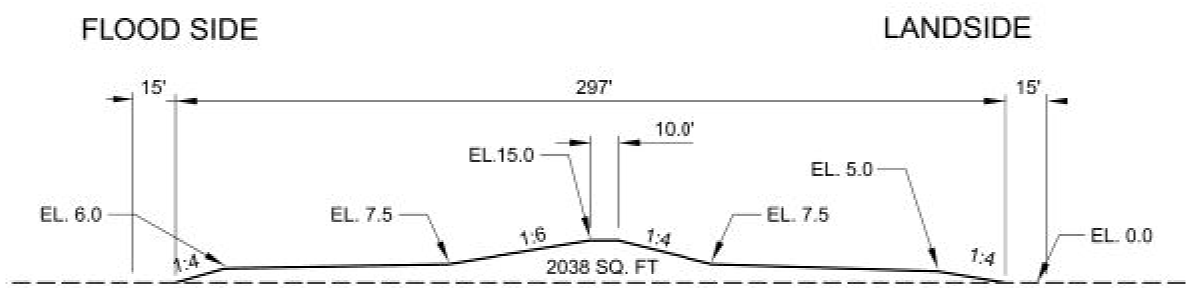


Figure 6-2 - Typical Section Reach B – NTS

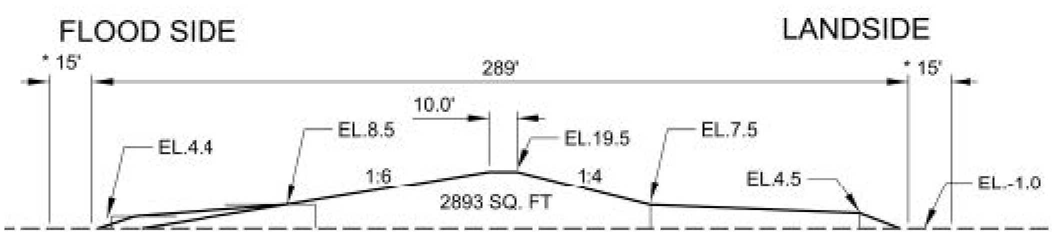


Figure 6-3 - Typical Section Reach E (CPRAB) – Not to Scale (NTS)

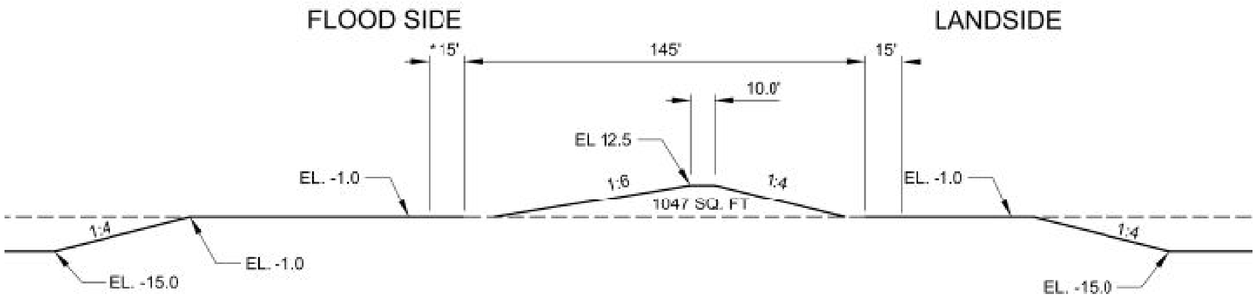


Figure 6-4 - Typical Section Barrier Reach – NTS

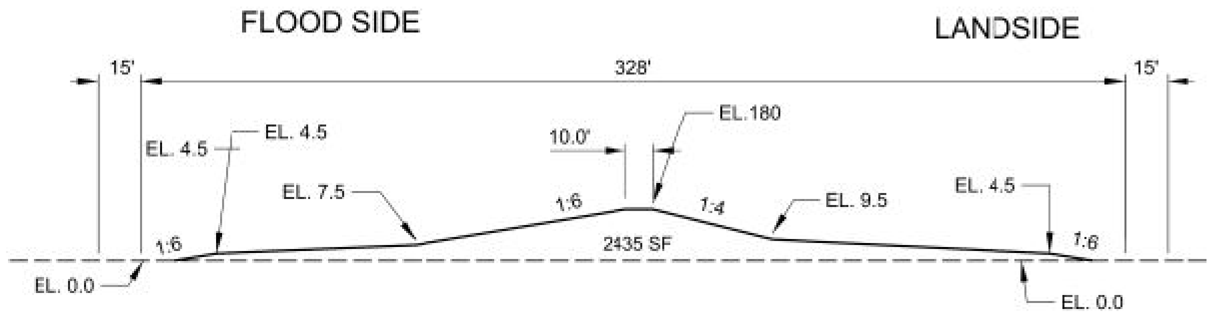


Figure 6-5 - Typical Section Reach F– NTS

6.3 CIVIL ENGINEERING

With geotechnical engineering design sections complete, civil engineers developed cross-sectional areas multiplied by reach lengths to develop neat-line embankment quantities. Quantities of borrow placed to date were provided by local stakeholders. Since quantity of borrow was provided (versus quantity of embankment), local furnished quantities were reduced by 20% to account for compaction during material placement. New design section quantities less the stakeholder quantities placed to date provided cost engineers with the quantities needed (by reach) to attain the 1% AEP LORR. See Appendix C for a tabular listing of quantity dimensions and quantity calculations.

For levee reaches for which construction of the first lift has not begun, the difference in design section quantities was increased by 20% to account for lateral spread. For levee reaches for which initial construction to approximate EL 12 has been completed, the difference in design section quantities was increased by 35% to account for lateral spread and foundation settlement that has occurred since construction. Civil engineers also developed levee area acreage for computing clearing/grubbing and fertilizing/seeding/mulching costs.

6.4 COST

Cost engineers developed new unit costs for the revised levee quantities and worked with structural engineers to develop new structure quantities based on revised hydraulic design elevation requirements and conversion of most of the flood gates from sector gates to barge gates. All future levee construction is assumed to be built following typical CEMVN levee construction techniques using truck-hauled embankment, with the exception of Reach K, which requires barge delivery for the majority of the length.

The embankment construction unit cost ($/CY) for the revised levee design sections was based on an average 7-mile one-way truck haul distance. The haul distance was provided by TLCD based on the haul distances they have been experiencing for the alignments constructed to date. This appears to be reasonable based on a review of mileage arcs on the local stakeholder furnished borrow map, which is provided in Appendix B. The unit cost for levee embankment includes basic assumptions for borrow pit development (i.e., pit management, excavation, on-site processing/moisture control), loading, truck hauling, spreading, compacting, testing, and truck wash racks. The cost for truck wash racks was removed from the Barrier Reach, Reach A, Reach B, and the Lockport to Larose Reach, where it is assumed the levee is directly accessible without transiting on highways. The overall levee construction cost also includes parameters such as mobilization/demobilization, levee clearing, embankment construction, and fertilizing, seeding, and mulching.

In addition to revised quantities resulting from updated hydraulic design elevations and conversion of sector gates to barge gates, costs for structures included new fabricated steel prices furnished by the local stakeholders based on actual construction data (bid schedules) for constructed features. A reduction in quantities was realized for foundations, structural concrete, and structural steel for most structures including floodgates, roadway gates, and corresponding floodwalls. The cost development assumes unrestricted solicitations as the contracting method.

6.4.1 RELOCATIONS

Based on local stakeholder input, relocations identified in the PACR have predominantly not been completed in compliance with USACE criteria for reaches constructed to date. Approximately 47 miles of the PACR alignment (98 miles in total) have been constructed to elevation 12. Due to time and scope limitations, the PDT was unable to go through the entire alignment to determine which utility relocations have been performed in compliance with USACE criteria. Ultimately the PDT retained the quantities developed for the PACR and updated the cost to 2020 dollars using prevailing cost rates and data. The PACR quantities assumed that no utility relocations have occurred on the footprint that has been constructed by the NFS, though it is likely that some relocations have occurred in 47 miles of levee alignment that has been constructed on. Therefore, it was decided to take a conservative approach and assume that all utililites would need to relocated.

6.4.2 S&A, E&D, AND CONTINGENCY

As new costs for all alignment parameters were completed, Cost Engineering then applied the same PACR percentages for S&A and E&D to the TPC. No reduction in these percentages can be justified; however, the overall cost of these parameters is reduced based on an overall reduction of alignment features cost. Overall project contingency is based on the risk register, and corresponding Crystal Ball output, which has been submitted with the MII estimates for review as part of the cost certification.

6.5 STRUCTURES

Hydraulic engineers furnished structural engineers with new hydraulic design elevations for the structures. Predominantly, structural engineers pro-rated quantities developed for structures during the 2013 PACR. For the 56 ft barge gate structures, previously assumed to be sector gates in the PACR, a limited design approach was followed, utilizing existing designs from local stakeholders constructed within the last 10 years. In summary, reductions were realized for the foundations, structural concrete, and structural steel for all structures, including floodgates, roadway gates, and corresponding floodwalls. The revised quantities were provided to cost engineering for input to the MII estimates using prevailing cost data and rates, resulting in the new costs for structures. Details of the structural design approach for the current design can be found in Appendix E.

7.0 RISK

This report documents changes from the project described in the PACR. Another objective is to furnish the cost engineering review team members with a basis, rational, and quantity/cost traceability required to certify the current MII cost estimate and associated risk register/crystal ball output for contingency. As is the case for all Civil Works construction efforts, additional data collection, re-design, and corresponding updated cost estimates shall be required to verify the findings throughout PED as detailed plans and specifications for construction contracts are developed. The PDT collaboratively developed a risk register, and MVN Cost Engineering developed a formal Crystal Ball analysis to produce a contingency intended to mitigate the risk associated with TPC.

Local stakeholder efforts to construct approximately 47 miles of levee have significantly reduced the uncertainty in future risk during PED and the corresponding cost estimate and contingency. The MTG alignment has an extensive amount of subsurface, survey, and levee construction data that has been collected by local interests and leveraged as part of this study – considerably more than most new studies, especially those under "3x3x3" constraints. Moreover, required levee construction heights, a significant source of uncertainty in most new studies in southeast Louisiana, are much clearer today due to the consolidation settlement that has already occurred since the previous levee construction. Lastly, the successful construction of levees has given clarity and confidence that the assumed design criteria and construction methods will be effectively implemented during future phases of the MTG project.

8.0 QUALITY REVIEWS

Quality reviews were completed for the current effort as well as the ACAR under a vertical team review. The ACAR was reviewed through the USACE vertical chain of command up to HQ. The approach defined in the ACAR was applied and refined in the current design.

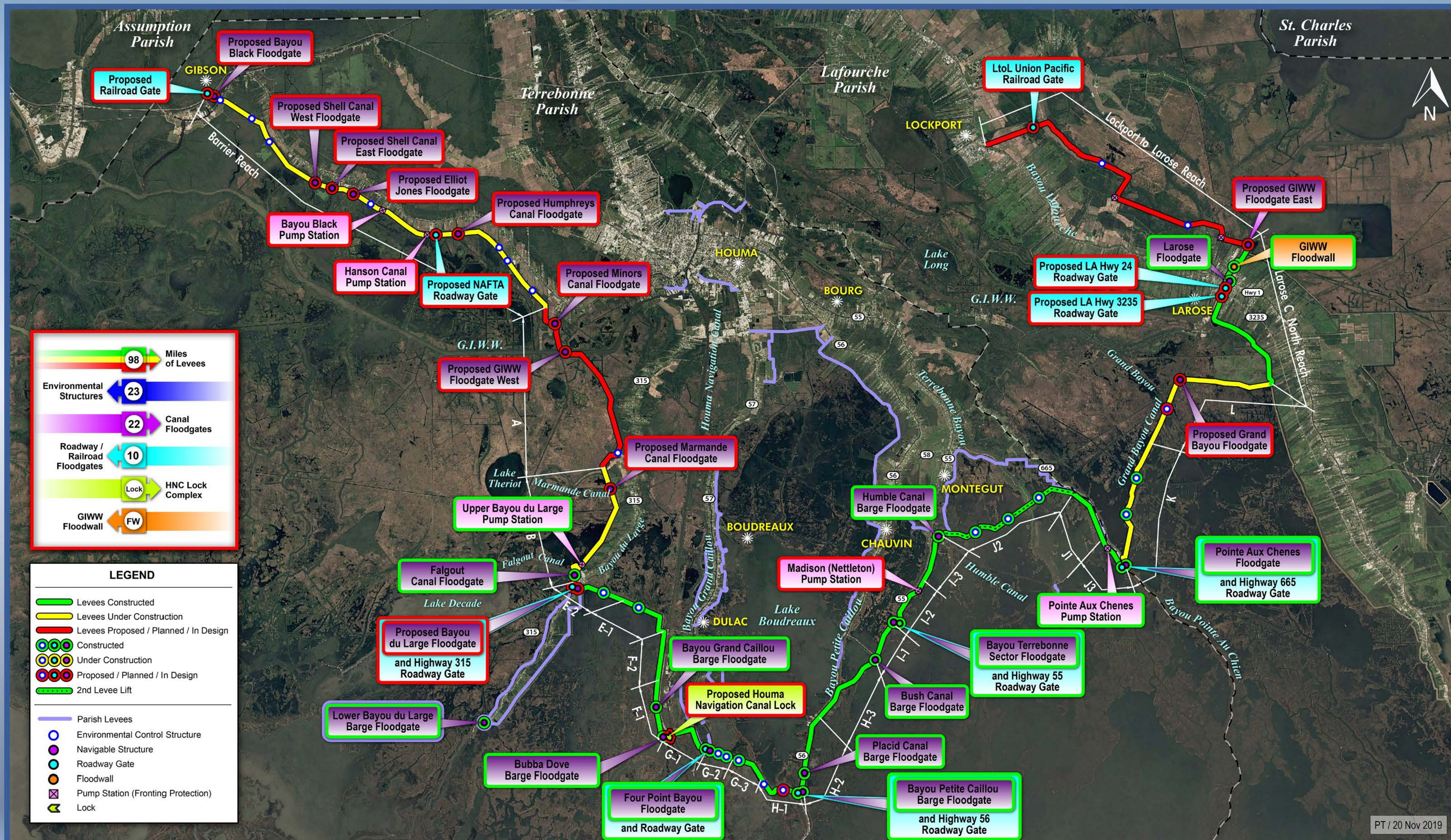
9.0 CONCLUSION

The results of the 2021 engineering review of costs have confirmed the recommendations from 2019 ACAR of utilization of "adaptive criteria" representes a valid approach and, thus, those recommendations have been incorporated in the current design as recommended in this report and in the Engineering Documentation Report. The current design resulted in a TPC of approximately $6B, and the 2035 cost to achieve a "closed" 1% AEP system is approximately $3.6B. The exact cost figures are included in the MII outputs, which have been provided to the Cost Center of Expertise for certification as part of the update to the current design in support of this EDR.

Appendix A

Project Map

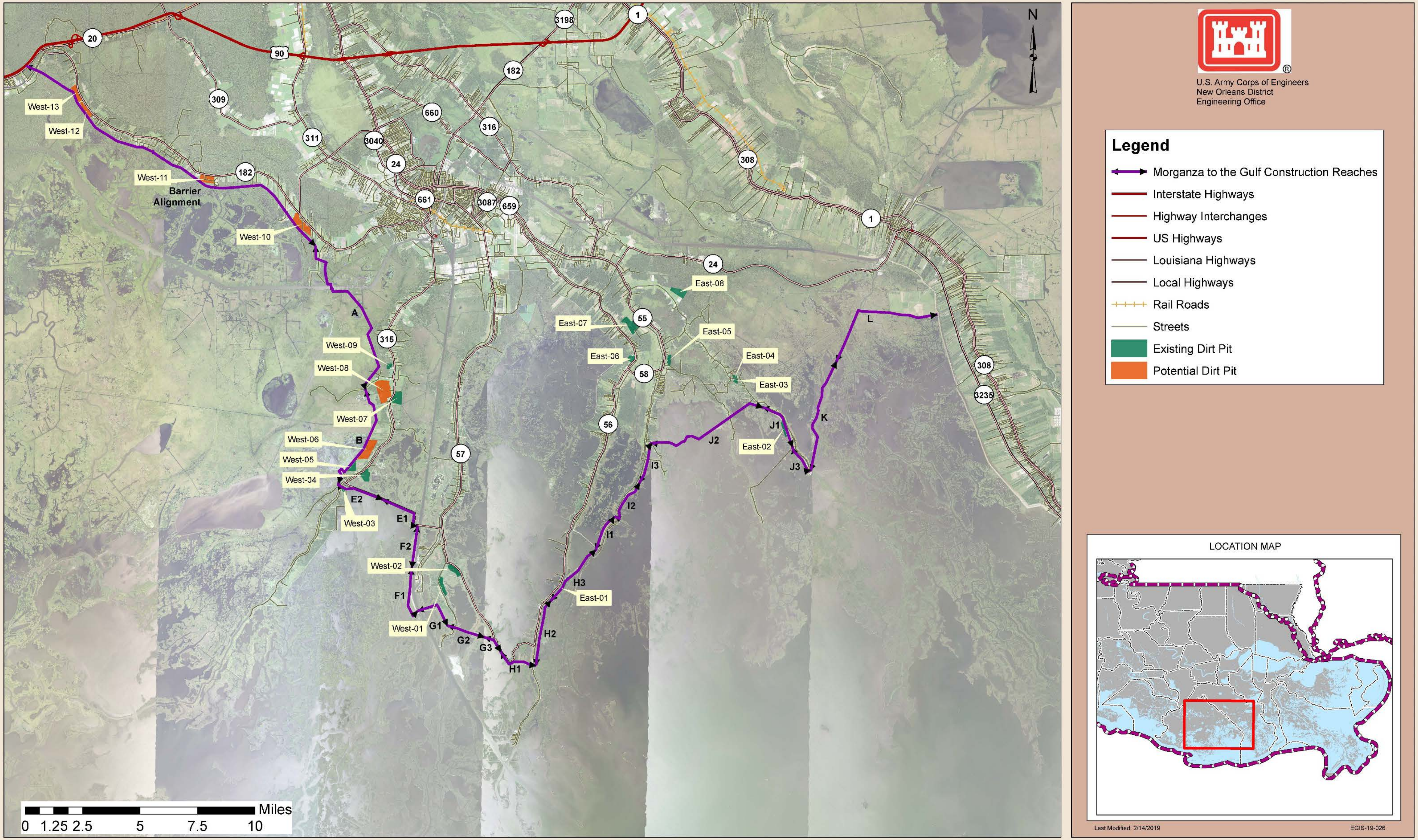
Morganza to the Gulf



Appendix B

Borrow Map

Morganza to Gulf Borrow Pits Map



Appendix C

Levee Quantities & List of Structures by Reach

APPENDIX C
MORGANZA TO THE GULF
LEVEE QUANTITIES AND LIST OF STRUCTURES BY REACH
1% Design, 2035

Dec 2020 EDHH - Hydraulic Reachs	ACAR Project/Reach	Projected reach	Total Reach Length (FT)	X-sectional area (SF)	NFS Embankment Placed	update Dec 2020 lift (CY)	Levee (AC)
A-North of GIWW		B					
A-South of GIWW	Reach A	B	43,184	2,038		4,400,450	324
B	Reach B		26,786	2,038		2,729,493	201
E2	Reach E		22,966	2,893	746,355	2,314,452	168
E1							
F2	Reach F (Lower)		22,583	2,435	1,226,042	1,094,323	186
F1	Reach F (Upper)			0			
G1	Reach G-2A	E	24,388	2,893	887,212	2,329,988	179
G2	Reach G-2B	E		0			
G3	Reach G-2C	E		0			
	Reach G-1	E		0			
H1	Reach H-3	J2	41,366	4,113	1,360,239	6,670,595	452
H2	Reach H-2	J2		0			
H3	Reach H-1	J2		0			
I1	Reach I	J2	30,168	4,769	290,186	6,801,809	330
I2		J2					
I3		J2					
J2	Reach J-3		49,357	4,769	2,992,195	7,729,713	539
J1	Reach J-1	J2		0			
J3	Reach J-2	J2		0			
K	Reach K	J2	26,961	4,769	0	5,714,534	294
L	Reach L	J2	31,143	4,769	291,867	6,250,691	
C-North	Larose C North Reach		36,960			0	
GIWW						0	
Lockport-A	Lockport to Larose R	BARRIER	77,531	1,047		3,607,776	311
Lockport-B		BARRIER					
Barrier	Barrier		83,081	1,047		4,349,290	335
						53,993,115	3319

APPENDIX C
MORGANZA TO THE GULF
LEVEE QUANTITIES AND LIST OF STRUCTURES BY REACH
2050 1% Design

Project/Reach	Total Reach Length (FT)	Cross sectional area (SF)	Volume (CY)	Adjusted Volume (CY)	Section width (FT)	Levee Area (AC)
Barrier Reach	83,081	402	1,236,984	1,484,381	235.00	448
Reach A	43,184	770	1,231,544	1,477,852	375.00	372
Reach B	26,786	770	763,897	916,676	375.00	231
Reach E	22,966	729	620,082	837,111	330.00	174
Reach F (Lower) Reach F (Upper)	22,583	855	715,128	965,423	399.00	207
Reach G-2A Reach G-2B Reach G-2C Reach G-1	24,388	729	658,476	888,943	330.00	185
Reach H-3 Reach H-2 Reach H-1	41,366	1,124	1,722,051	2,324,769	495.00	470
Reach I	30,168	1,124	1,255,883	1,695,442	495.00	343
Reach J-3 Reach J-1 Reach J-2	49,357	1,124	2,054,714	2,773,863	495.00	561
Reach K	26,961	1,124	1,122,376	1,346,852	520.00	322
Reach L	31,143	1,124	1,296,472	1,750,237	495.00	354
Larose C North Reach	36,960	848	1,160,818	1,392,981	235.00	199
Lockport to Larose Reach	77,531	402	1,154,350	1,385,221	235.00	418
				19,239,750		4,283

Notes:

1. Adjusted difference includes 20% increase in quantity to account for lateral spread in reaches in which NFS has yet to complete any alignment.
2. Adjusted difference includes 35% increase in quanity to account for lateral spread and settlement during construction in which NFS has completed alignment.
3. Section Width-Assumed 15' VFZ each side plus additional 25' on landside for construction easement/access for all reaches without NFS completed alignment
4. On reaches where NFS has completed alignment, assumed 15' each side for disturbed areas

APPENDIX C
MORGANZA TO THE GULF
LEVEE QUANTITIES AND LIST OF STRUCTURES BY REACH
IN SUPPORT OF THE 2021 ECONOMIC ANALYSIS
2070 1% Design

Project/Reach	Total Reach Length (FT)	Cross sectional area (SF)	Volume (CY)	Adjusted Volume (CY)	Section width (FT)	Levee Area (AC)
Barrier Reach	83,081	456	1,403,146	1,683,775	255.00	486
Reach A	43,184	643	1,028,419	1,234,103	388.00	385
Reach B	26,786	643	637,904	765,484	388.00	239
Reach E	22,966	450	382,767	516,735	303.00	160
Reach F (Lower) Reach F (Upper)	22,583	551	460,860	622,162	407.00	211
Reach G-2A Reach G-2B Reach G-2C Reach G-1	24,388	450	406,467	548,730	303.00	170
Reach H-3 Reach H-2 Reach H-1	41,366	698	1,069,388	1,443,673	501.00	476
Reach I	30,168	698	779,899	1,052,863	501.00	347
Reach J-3 Reach J-1 Reach J-2	49,357	698	1,275,970	1,722,559	501.00	568
Reach K	26,961	698	696,992	836,390	526.00	326
Reach L	31,143	698	805,104	1,086,891	501.00	358
Larose C North Reach	36,960	900	1,232,000	1,478,400	255.00	216
Lockport to Larose Reach	77,531	456	1,309,412	1,571,295	255.00	454
				14,563,060		4,394

Notes:

1. Adjusted difference includes 20% increase in quantity to account for lateral spread in reaches in which NFS has yet to complete any alignment.
2. Adjusted difference includes 35% increase in quanity to account for lateral spread and settlement during construction in which NFS has completed alignment.
3. Section Width-Assumed 15' VFZ each side plus additional 25' on landside for construction easement/access for all reaches without NFS completed alignment
4. On reaches where NFS has completed alignment, assumed 15' each side for disturbed areas

APPENDIX C
MORGANZA TO THE GULF
LEVEE QUANTITIES AND LIST OF STRUCTURES BY REACH
2070 1% Design

Structure	Constructed (Y/N)
Barrier Reach	
Bayou Black Floodgate	N
Environmental Control Structure	N
Environmental Control Structure	N
Environmental Control Structure	N
Shell Canal West Floodgate-Stoplog	N
Shell Canal East Floodgate	N
Elliot Jones Floodgate-Stoplog	N
Environmental Control Structure	N
Bayou Black Pump Station FP	N
Hanson Canal Pump Station FP	N
NAFTA Roadway Gate	N
Humphreys Canal Floodgate-Stoplog	N
Environmental Control Structure	N
Environmental Control Structure	N
Environmental Control Structure	N
Reach A	
Minors Canal Floodgate	N
GIWW Floodgate West	N
Environmental Control Structure	N
Reach B	
Marmande Canal Floodgate-Stoplog	N
Upper Bayou du Large Pump Station	Y
Falgout Canal Floodgate	Y
Reach E	
Bayou du Large Floodgate	N
Highway 315 Roadway Gate	N
Environmental Control Structure	Y
Environmental Control Structure	Y
Reach F	
Grand Caillou Barge Floodgate	Y
Houma Navigation Canal Lock	Y
Bubba Dove Barge Floodgate	Y

APPENDIX C
MORGANZA TO THE GULF
LEVEE QUANTITIES AND LIST OF STRUCTURES BY REACH IN SUPPORT OF THE 2021 ECONOMIC ANALYSIS
2070 1% Design

Reach G	
Four Point Bayou Floodgate	Y
Four Point Bayou Roadwaygate	Y
Environmental Control Structure	Y
Environmental Control Structure	Y
Environmental Control Structure	Y
Reach H	
Environmental Control Structure	N
Environmental Control Structure	N
Bayou Petite Caillou Barge Floodgate	Y
Hwy 56 Roadway Gate	Y
Placid Canal Barge Gate	Y
Reach I	
Bush Canal Barge Gate	Y
Bayou Terrebonne Floodgate	Y
Hwy 55 Roadway Gate	Y
Madison (Nettleton) Pump Station FP	N
Humble Canal Barge Gate	Y
Reach J	
Environmental Control Structure	Y
Environmental Control Structure	Y
Environmental Control Structure	Y
Pointe Aux Chenes Pump Station FP	Y
Pointe Aux Chenes Floodgate	Y
Hwy 665 Roadway Gate	Y
Reach K	
Environmental Control Structure	Y
Environmental Control Structure	Y
Reach L	
Environmental Control Structure	N
Grand Bayou Floodgate	N

APPENDIX C
MORGANZA TO THE GULF
LEVEE QUANTITIES AND LIST OF STRUCTURES BY REACH
2070 1% Design

Larose C North Reach	
LA Hwy 3235 Roadway Gate	Y
LA Hwy 24 Roadway Gate	Y
GIWW Floodwall	N
Gulf South PPL Fldwl	Y
Enbridge/Am Midstream PPL Fldwl	Y
Williams PPL Fldwl	Y
Larose Floodgate	Y
GiWW Floodgate East	N
Lockport to Larose Reach	
LtoL - Union Pacific RR gate	N
Environmental Control Structure	N
Environmental Control Structure	N

Appendix D

Hydraulics Input

1 Introduction

1.1 Study Area

The study area is about 60 miles southwest of New Orleans, Louisiana and includes most of Terrebonne Parish and the portion of Lafourche Parish between the eastern boundary of Terrebonne Parish and Bayou Lafourche. The authorized Morganza to the Gulf of Mexico project (MTG) was intended to function as a 1% annual exceedance probability (100-year) coastal storm damage risk reduction system. In addition to flood risk reduction, the structural features of the authorized project were designed to provide tidal exchange, environmental benefits, and navigational passage. Reference Figure 1 for a map showing the post authorization change Morganza to the Gulf levee alignment.

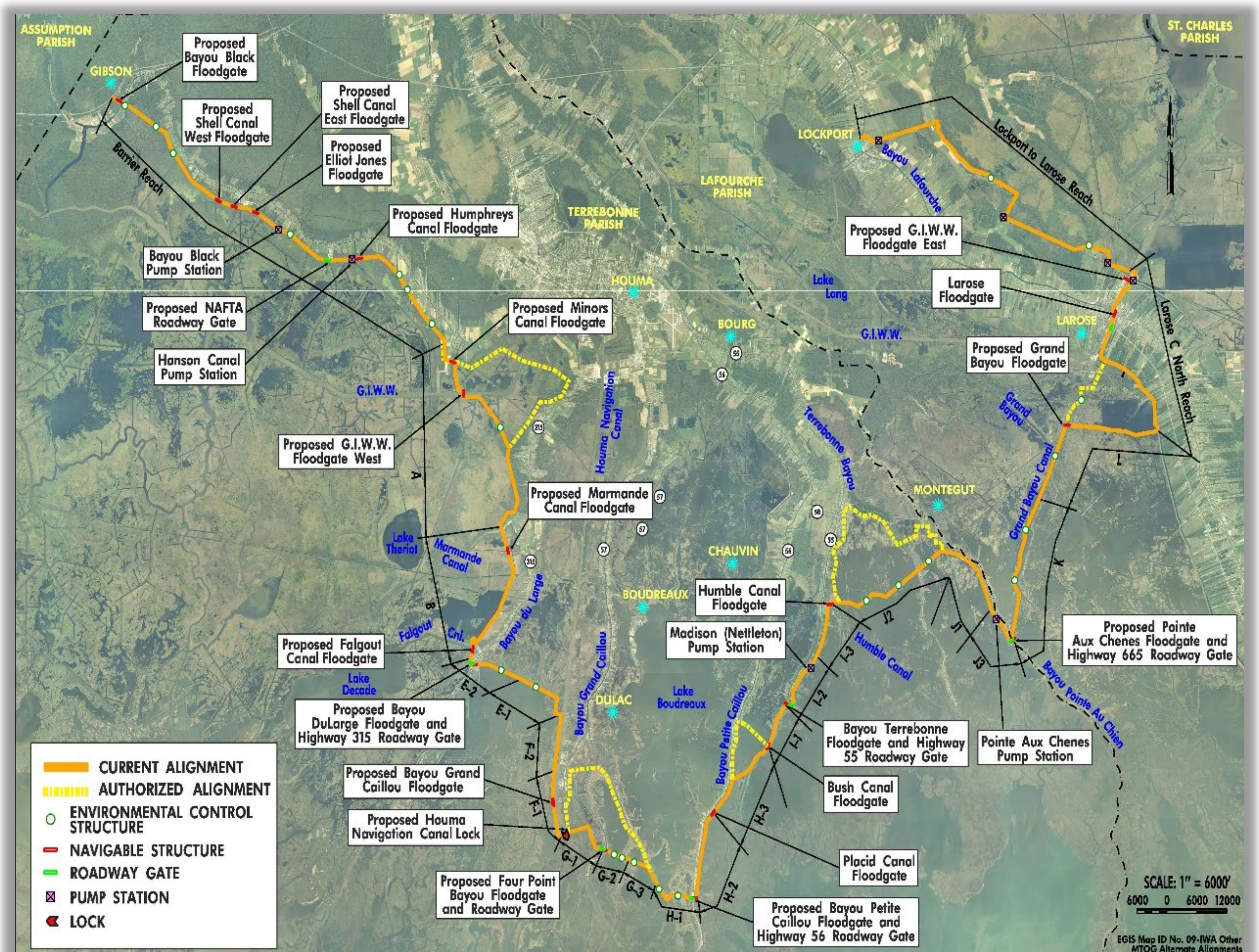


Figure 1-Morganza to the Gulf proposed levee alignment and reach names

2. Hydraulics

This section contains the methodology and results of the hydraulic investigations completed for the economic analysis including new ADCIRC modeling used to

establish interior and exterior frequency curves, levee designs and fragility curves.
All elevations are referenced to NAVD88 epoch 2004.65.

2.1 Storm Surge Assessment Methodology

The storm surge assessment task was used to determine stage frequency from hurricane storm surges impacting the Morganza to Gulf (MTG) project vicinity. The hydraulic modeling output provided stage-frequency for the 10-, 20-, 50-, 100-, 200-, 500- and 1000-year return periods.

ADCIRC + SWAN was used to model hurricane storm surges. It is a system of computer programs for solving time dependent, free surface circulation and transport problems. Version 53.04 was used for the analysis. The program utilizes the finite element method in space allowing the use of highly flexible, unstructured grids covering large domains as pictured in Figure 2, Typical ADCIRC applications include prediction of storm surge and flooding. See http://adcirc.org/ and for more http://swanmodel.sourceforge.net/download/download.htm information.

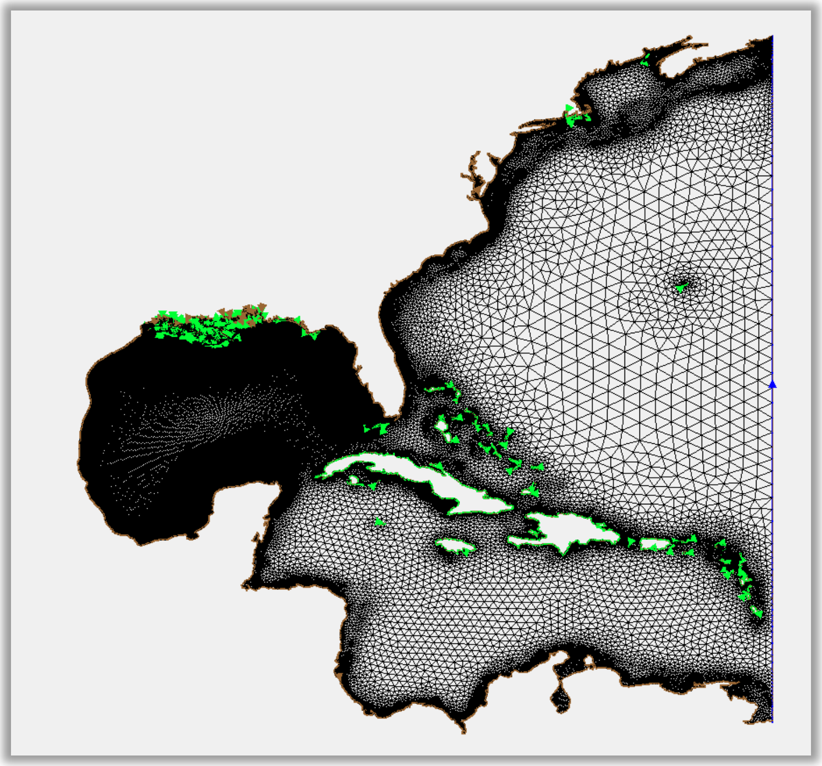


Figure 2-CPRA 2017 ADCIRC mesh

Matlab version R2017a was used to post process the ADCIRC data and run a water level statistics code produced by the U.S. Army Engineer Research and Development Center (ERDC).

2.1.1 With-and Without-Project Conditions

The existing conditions hydraulic modeling was completed using the 2017 Coastal Protection and Restoration Authority's (CPRA) 2017 Master Plan ADCIRC mesh. The mesh was developed to represent base conditions for the 2017 State Master Plan. The mesh is heavily validated and verified ADCIRC mesh which performs well for hindcasts of Katrina, Rita, Gustav, Ike, Isaac. More information concerning the mesh can be found online here:

http://coastal.la.gov/wp-content/uploads/2017/04/Attachment-C3-25.1_FINAL_04.05.2017.pdf

http://coastal.la.gov/our-plan/2012-coastal-masterplan/cmp-appendices/

Figure 3 displays the levee and other raised feature (roads, spoil banks, etc.) alignments in the MTG without coupled model mesh. The elevations of the raised features are based on ~2017 era surveys or lidar data, which is generally representative of 2020 conditions. Figure 4 displays the modified "With-Project" coupled model mesh. The MTG and Larose to Golden Meadow levee elevations were set to non-overtopping conditions.

Figure 3-Without-project levees and raised feature alignments

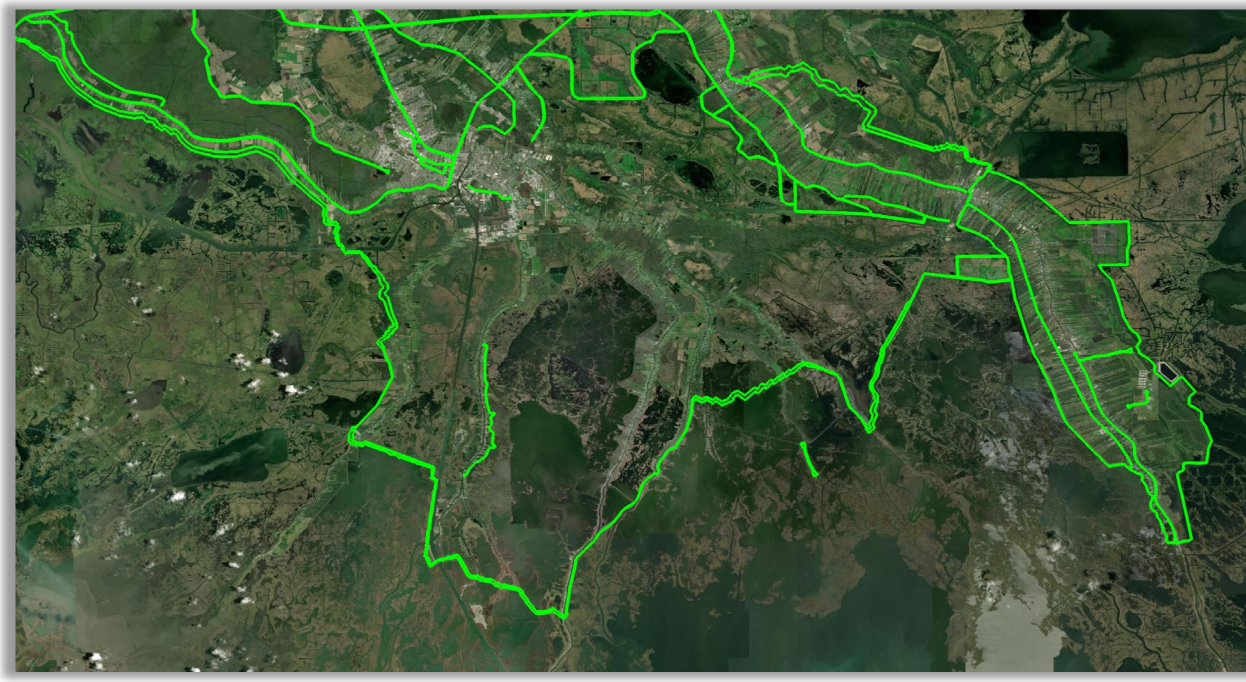


Figure 4- With-project levees and raised feature alignments

2.1.2 Synthetic Storms

Fifty-one (51) synthetic storms were selected with water level return intervals from 10 year to 500 year. The associated surge values were required for levee designs (100-year) and frequency curves for use in the HEC-FDA model (10- to 500- yr). The suite of storms was modeled for with-and without-project for existing and future conditions, which brings the total number of coupled ADCIRC SWAN model simulations to 204. The storms cover a range of hypothetical tracks and intensities as pictured in Figure 5 and Figure 6. Most of the storm tracks in the suite are west of overtop of the project area. These storms will likely show the largest surges along the exterior of the proposed levee but may not fully capture the flood inducements behind them which is outside of the scope of the project. Storms to the east of the project area could push water higher in the interior but will not contribute to increase stages on the exterior. For this analysis the storms on the west provided a more conservative estimate of the exterior stages required to develop levee design elevations and stages in the with project analysis. Additional storms from the full suite will be examined in PED.

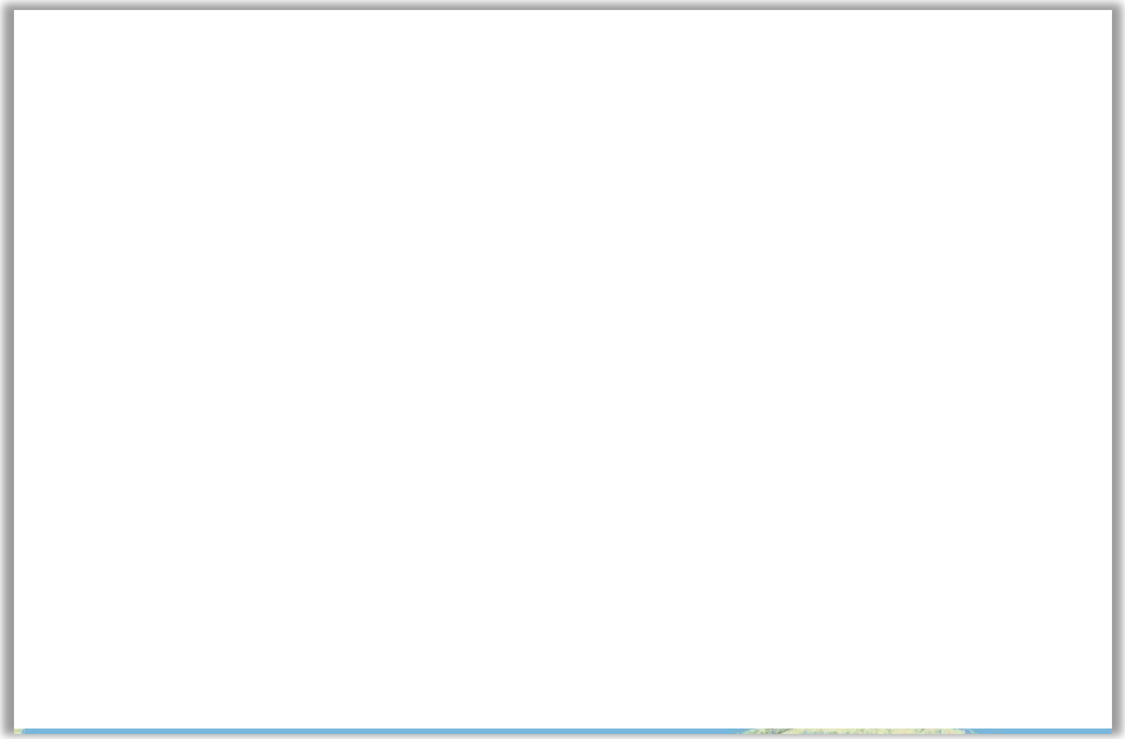


Figure 5-Synthetic storm tracks

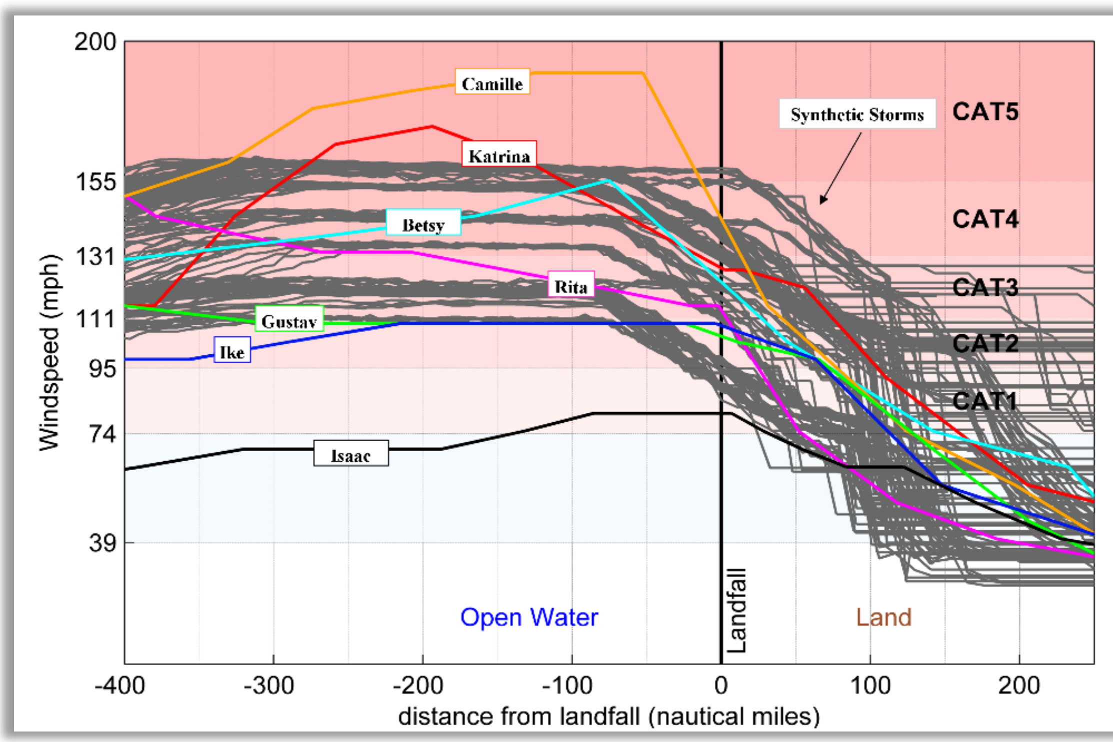


Figure 6-Synthetic and actual storm intensities

With-and Without-Project Results

The 51 synthetic storms were simulated with the couples ADCIRC +SWAN model for with-and without-project conditions. The coupled model computes maximum storm surge (water surface elevations, wave heights (Hs) and peak wave period (Ts) in the coupled model at node in the model mesh. Figure 7 displays the maximum water surface elevations for without-project conditions for synthetic storm 009. The simulation shows extreme flooding in the study area. Figure 8 displays the maximum water surface elevations for with-project conditions for synthetic storm 009. The simulation including the non-overtopping levee shows a vast reduction in flooding in the interior (protected side) and a significant increase in flooding on the exterior (flood side). Figure 9 displays the difference in maximum water surface elevations between with-and without-project. The difference plot shows the increase or stacking of water on the exterior is greater than 5ft for areas close to the levee, but tapers down further away from the levee. The return period of this storm surge in this area is roughly a 0.1% (1000-year).The difference plot for all synthetic storms shows similar patterns of exterior stacking and interior reductions of peak water surface elevations.

A regression analysis was performed to determine stage frequency for with-and without-project. Regression is needed to produce statistical results with a limited sub-suite of storms. It is computationally intensive to re-run the entire suite, so a sub-suite was used to perform a regression analysis. The maximum water surface results of all 51 synthetic storms for without-project are compared to with-project maximum water surfaces at all locations in the study area. The regression algorithm is completed at each node in the coupled model providing a continuous water level surface. The regression analysis allows prediction of the changes to the without-project stage-frequency due to the project based on results of all storms. Figure 10 displays the regression results at a location on the outside of the MTG levee. The regression analysis allows a generalized prediction of with-project stage frequency for both interior and exterior locations. Regression analysis includes extra error and uncertainty into the estimates. For this reason, all stage and wave frequency data should be reviewed and possibly recomputed during the Preconstruction Engineering and Design (PED) phase of the project. Figure 10 shows an increase of the with-project stage-frequency on the exterior due to the stacking of water that occurs on the levee exterior. The regression analysis uses a linear regression approach, providing a general trend of expected changes to stage-frequency. Figure 11 to 24 display the maximum storm surge for with- and without-project for the 10-, 20-, 50-, 100-, 200-, 500- and 1000-yr storm surge events for years 2020 and 2070. The bottom figure in each plot shows the maximum difference. Results of the ADCIRC model were used to develop levee and hydraulic structure design elevations and stage frequency curves. Stillwater elevations for year 2085 were linearly extrapolated from the nonlinear 2070 values derived from the ADCIRC model; stillwater elevations for the base year 2035 were interpolated from the results of the 2020 and 2070 model results. Stillwater values for returns lower than the 10-year were also extrapolated; values for the 25-year were interpolated as required for the HEC-FDA model stage frequency curves. Reference Sections 2.2 and 2.3 for more information on levee and hydraulic structure design elevation methodology and frequency curve development.

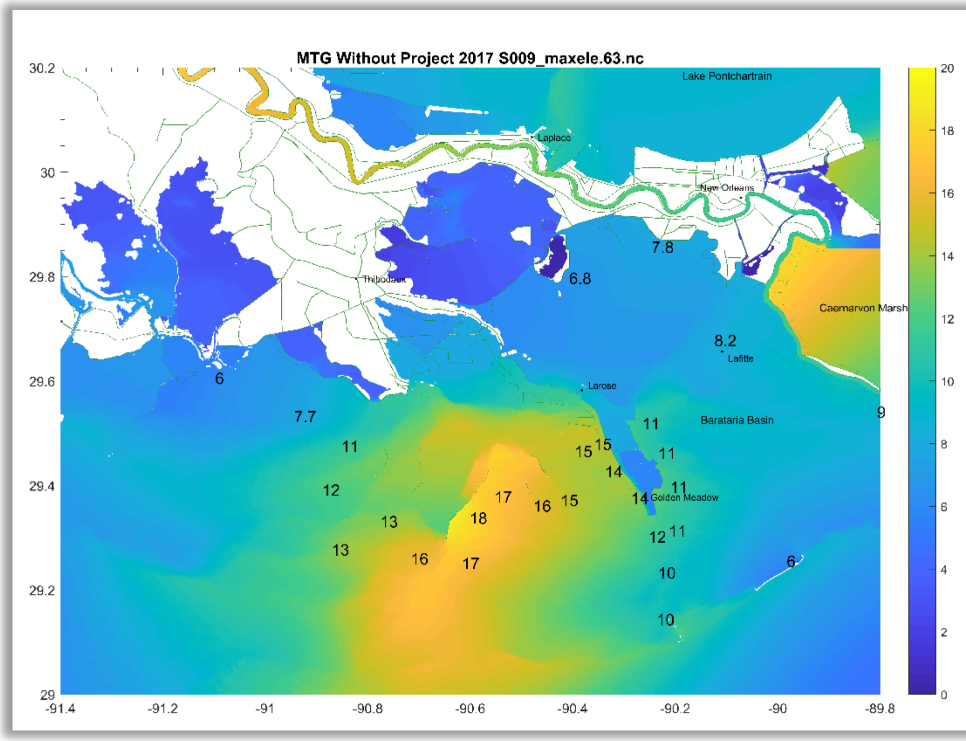


Figure 7-Without-project maximum water surface elevation synthetic storm 009

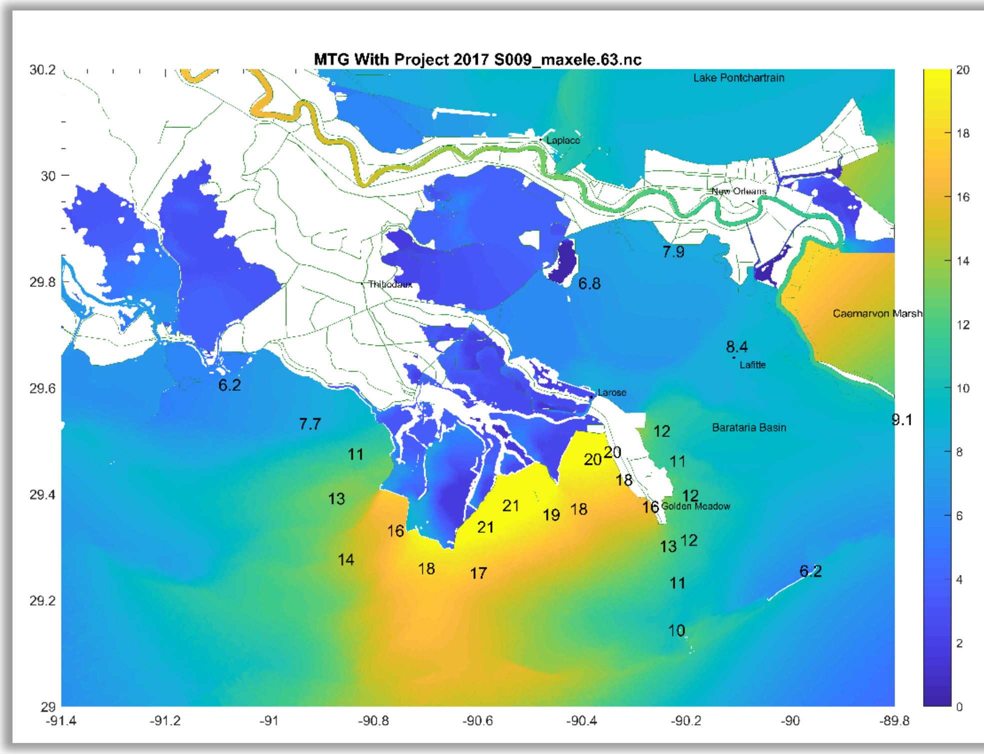


Figure 8-With-project maximum water surface elevation synthetic storm 009

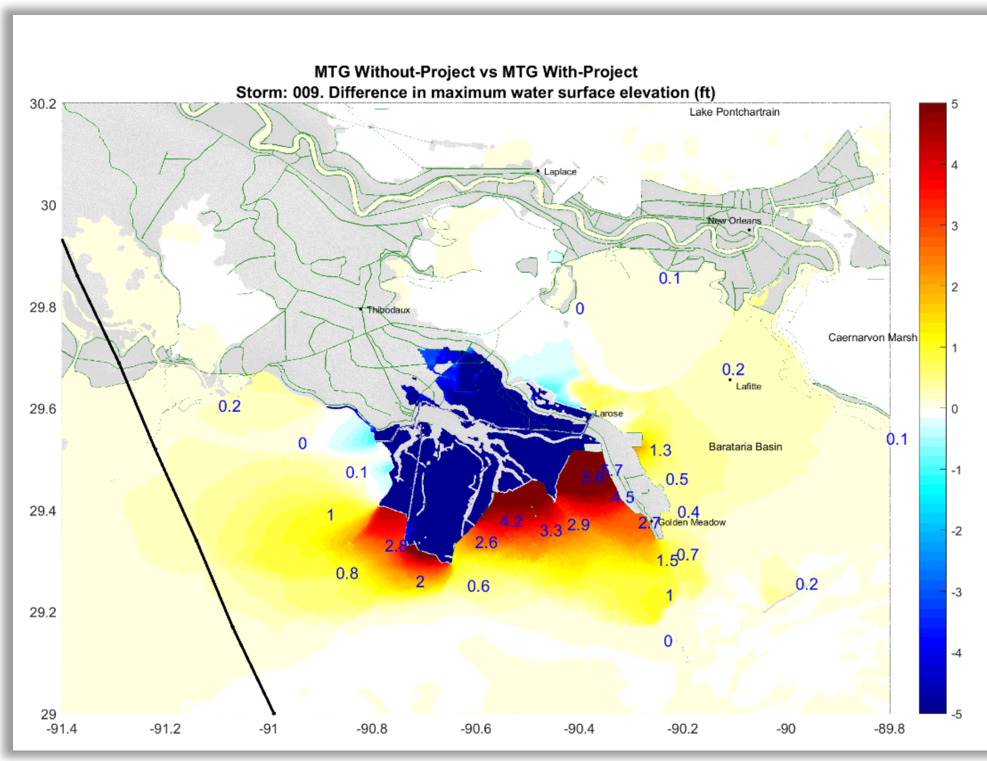


Figure 9-Difference in maximum water surface elevation for synthetic storm 009

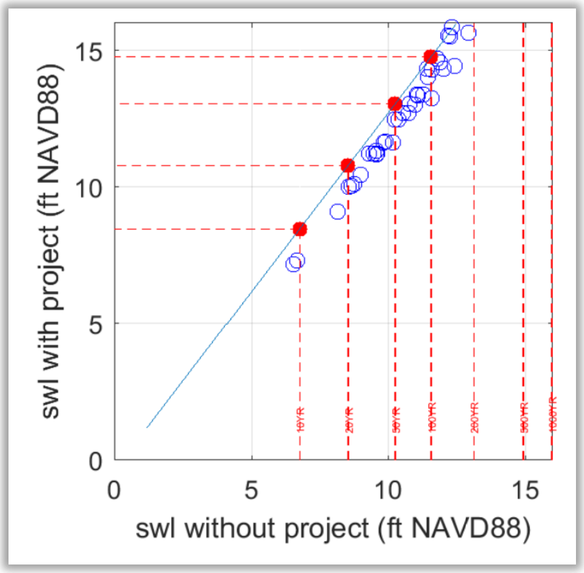


Figure 10 - Regression plot at a location outside of the MTG levee (NAVD88 epoch 2004.65)

2.1.4. Assumptions and Limitations

- Interior water level statistics were computed with the latest joint probability method-optimum sampling (JPM-OS) code from ERDC. The code was applied as-is with no modification or verification.
- The without-project interior stage frequency data does not include the effects of rainfall, wave overtopping, pumping, or levee breaching.
- The coupled ADCIRC + SWAN modeling includes a smaller subset of 51 synthetic storms. **During the PED phase design elevations should be reviewed and based on a more thorough analysis.**
- The statistical results are based on regression analysis, which introduces some uncertainty into the modeling. The data was examined for residual errors to minimize uncertainty within the model results. Lowliers and highliers were removed from the results.

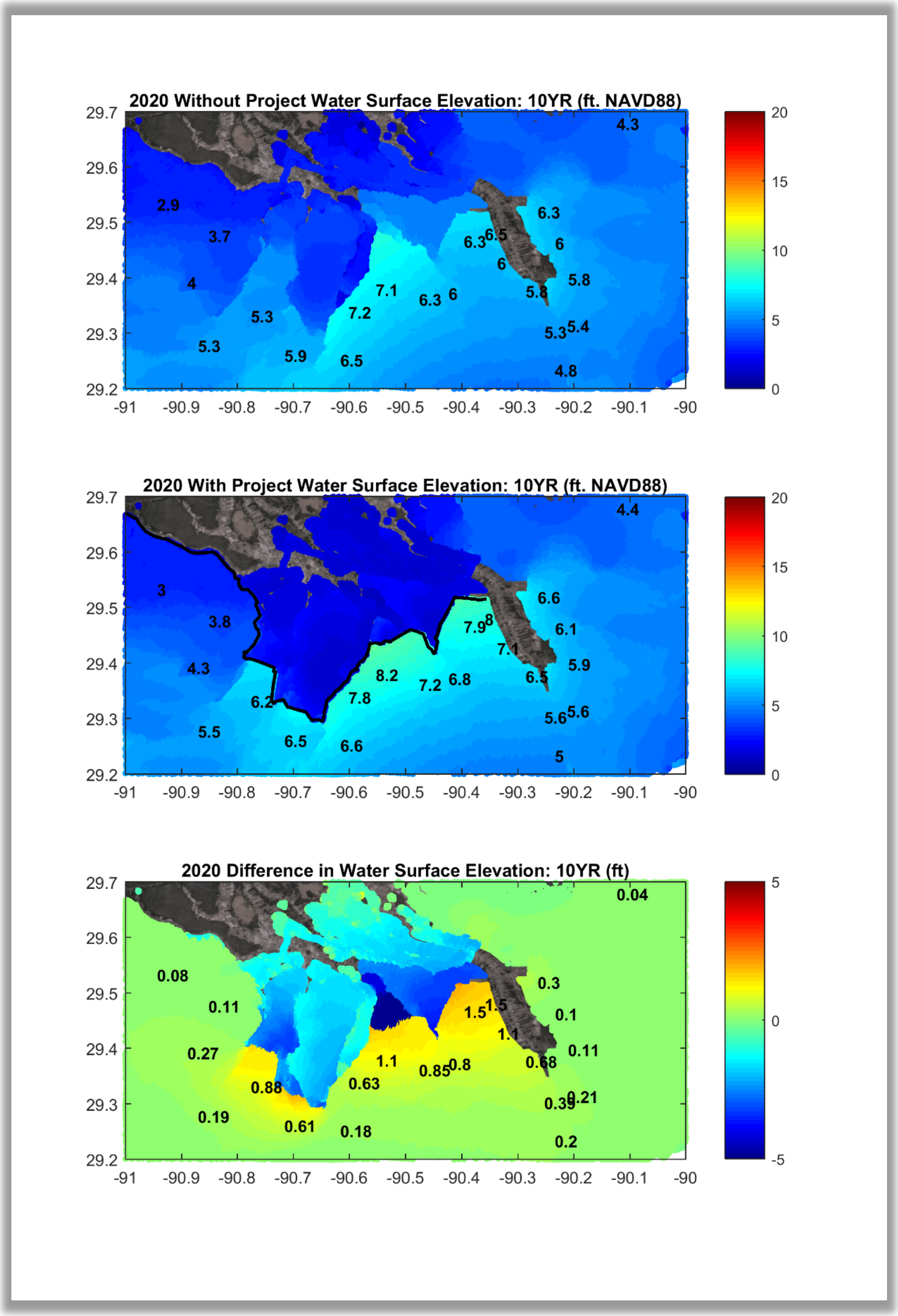


Figure 11-2020 with-and without-project maximum 10-year stillwater elevations and maximum difference between with-and without-project

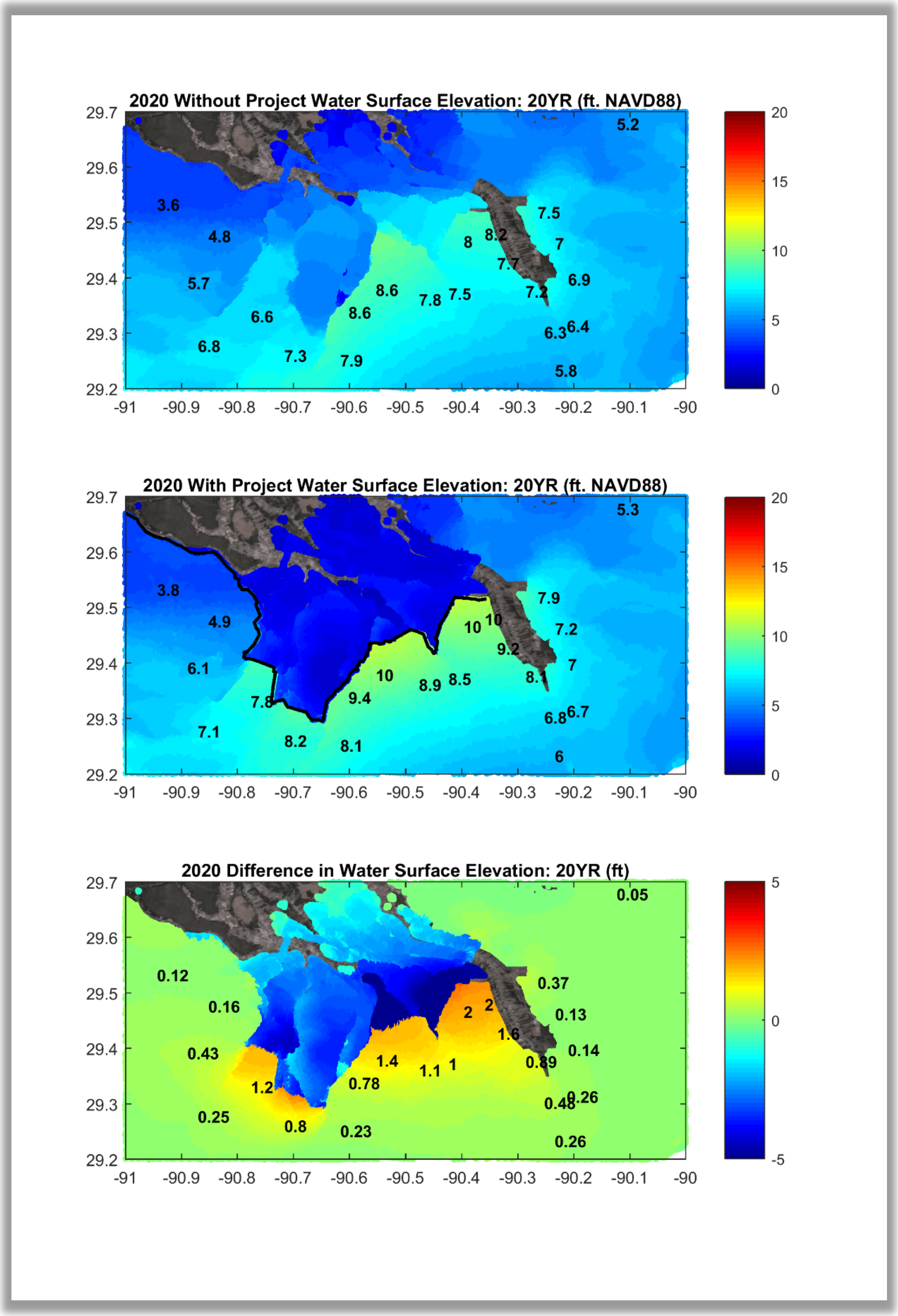


Figure 12-2020 with-and without-project maximum 20-year stillwater elevations and maximum difference between with-and without-project

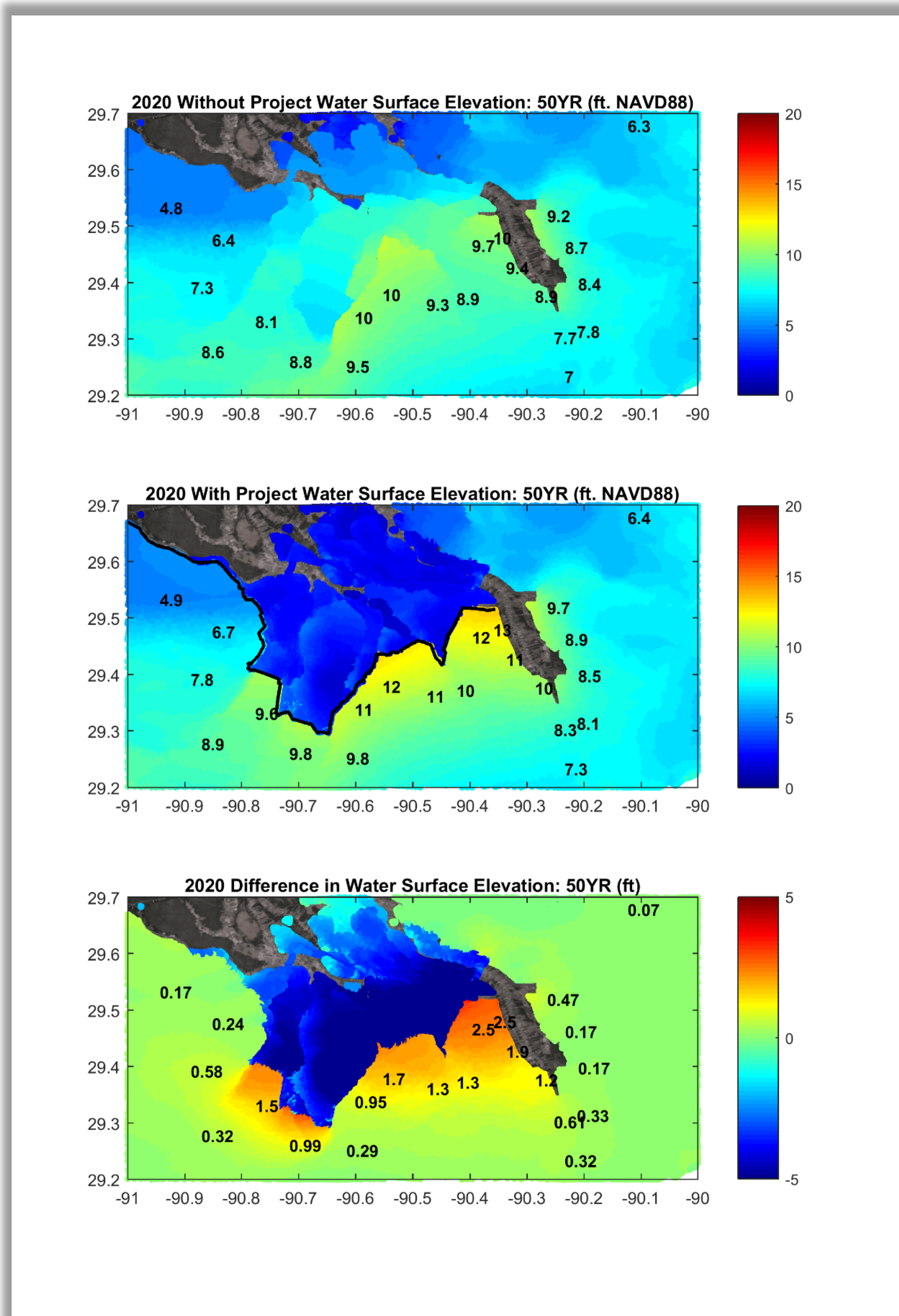


Figure 13-2020 with-and without-project maximum 50-year stillwater elevations and maximum difference between with-and without-project

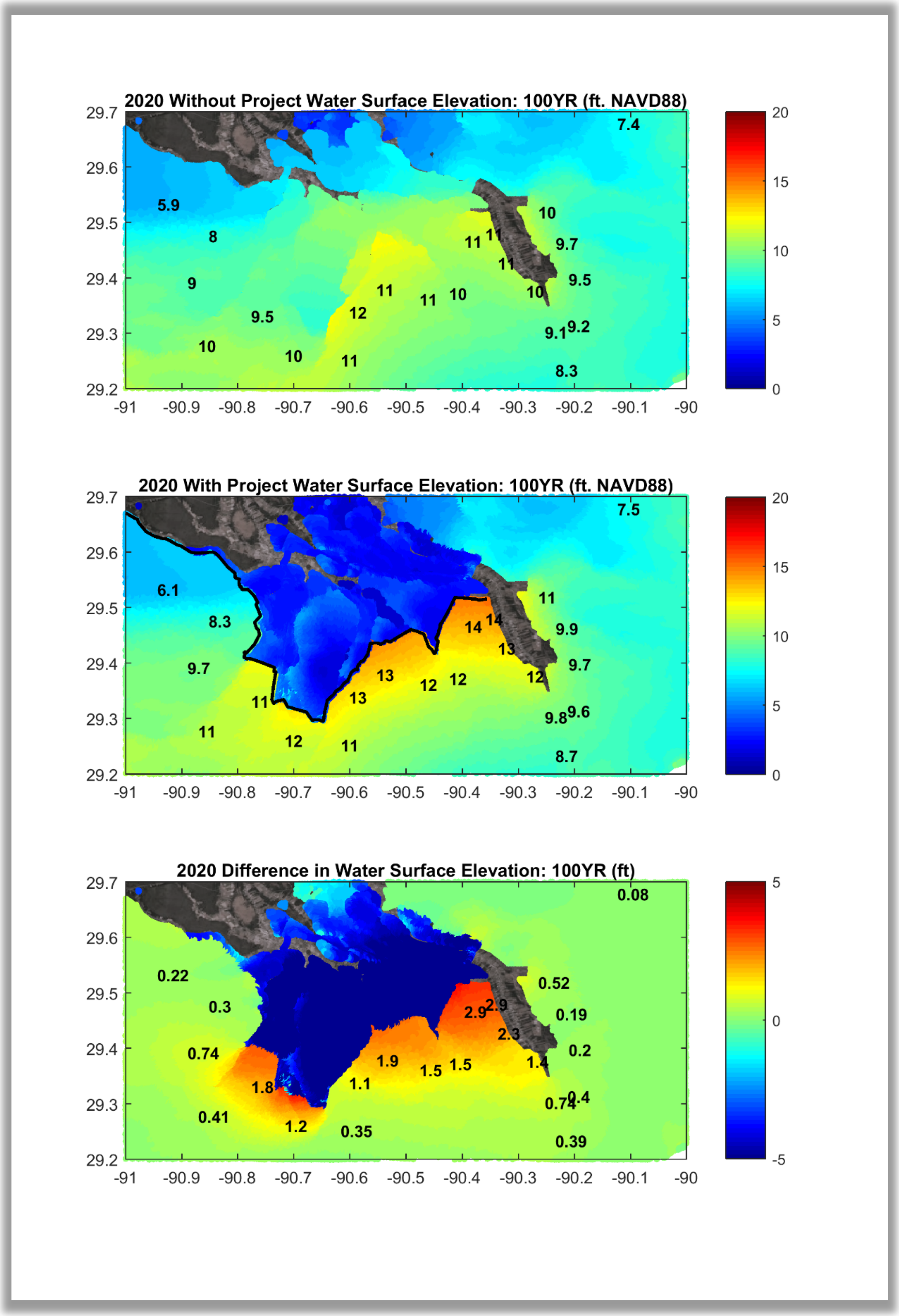


Figure 14-2020 with-and without-project maximum 100-year stillwater elevations and maximum difference between with-and without-project

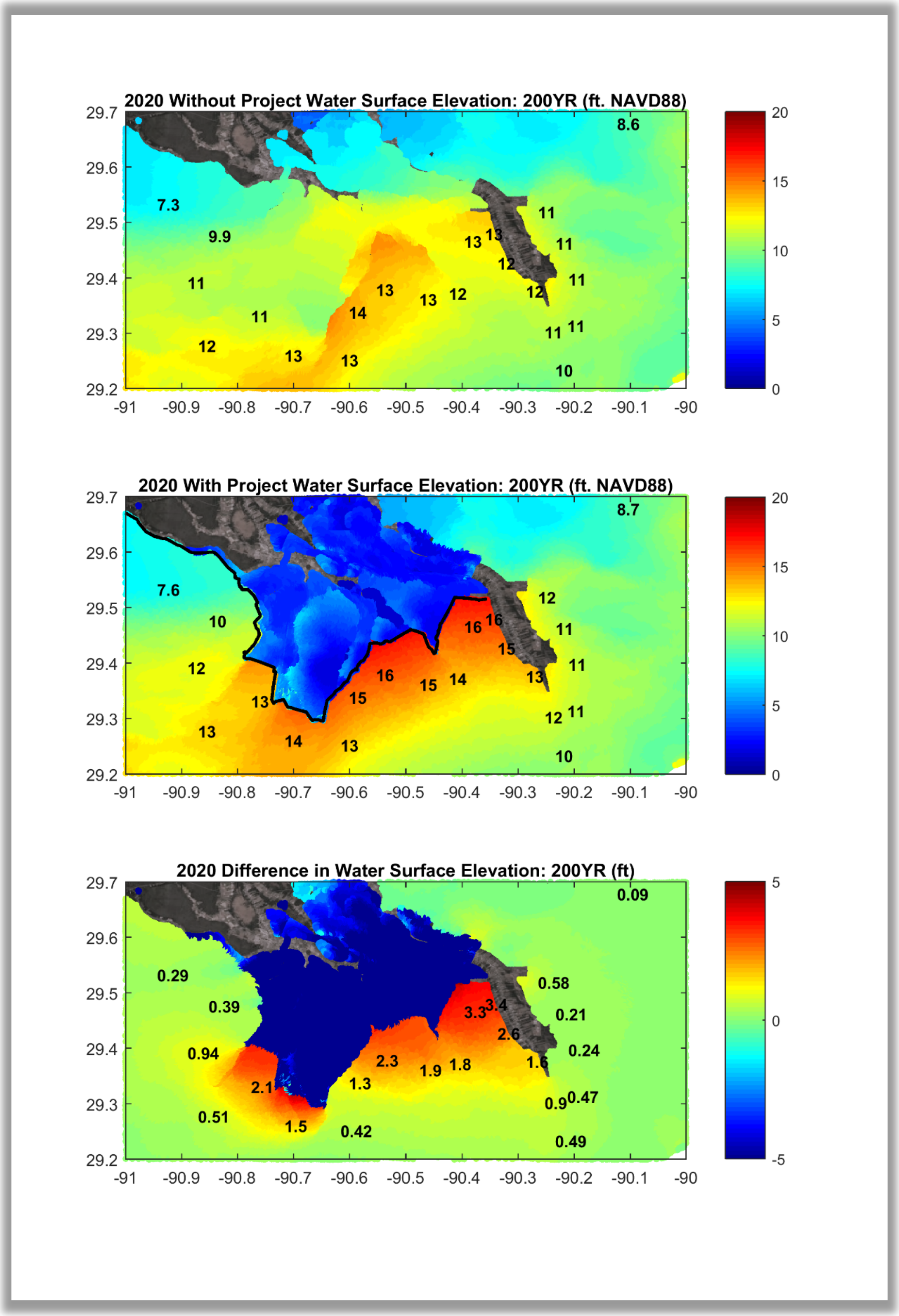


Figure 15-2020 with-and without-project maximum 200-year stillwater elevations and maximum difference between with-and without-project

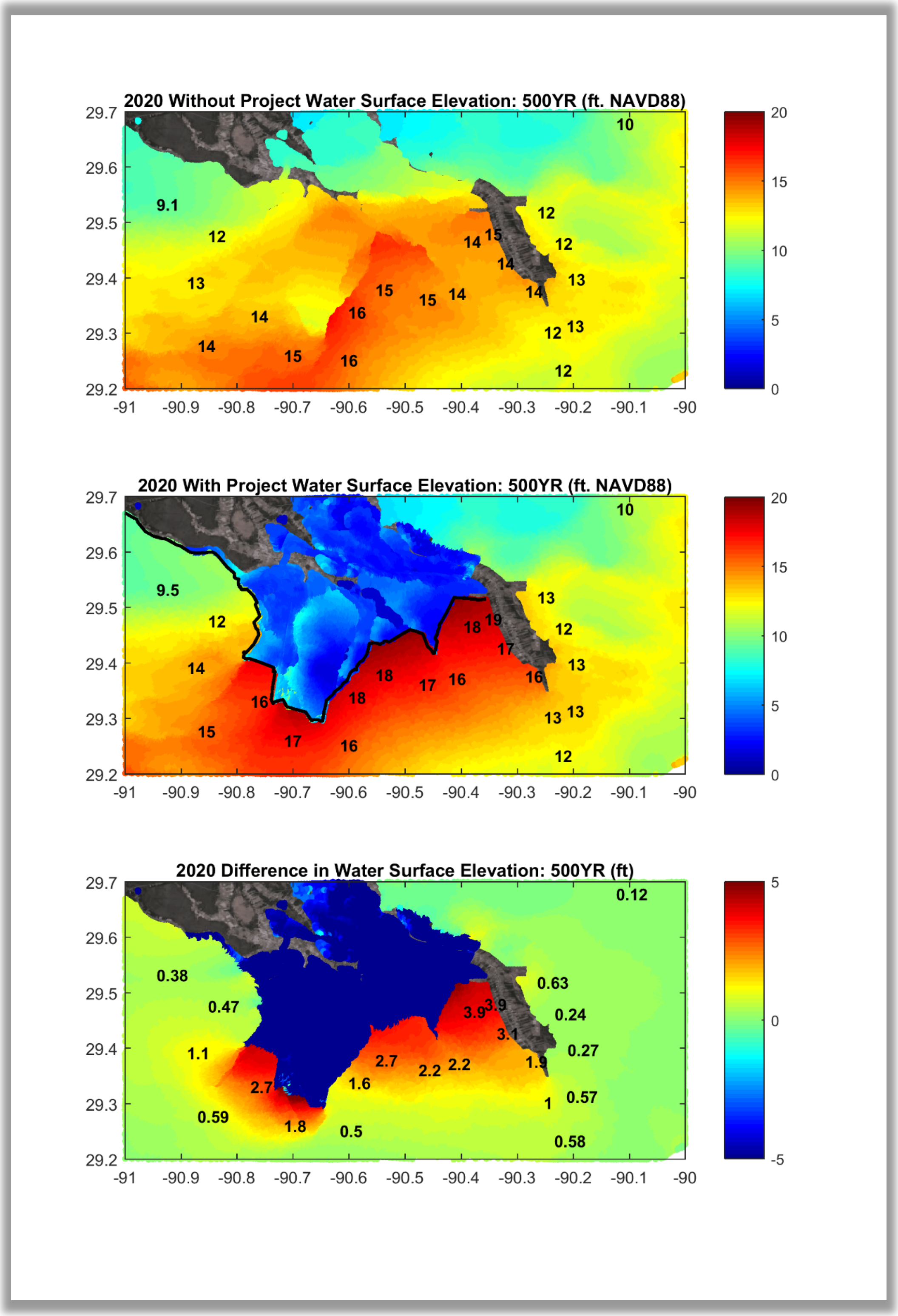


Figure 16-2020 with-and without-project maximum 500-year stillwater elevations and maximum difference between with-and without-project

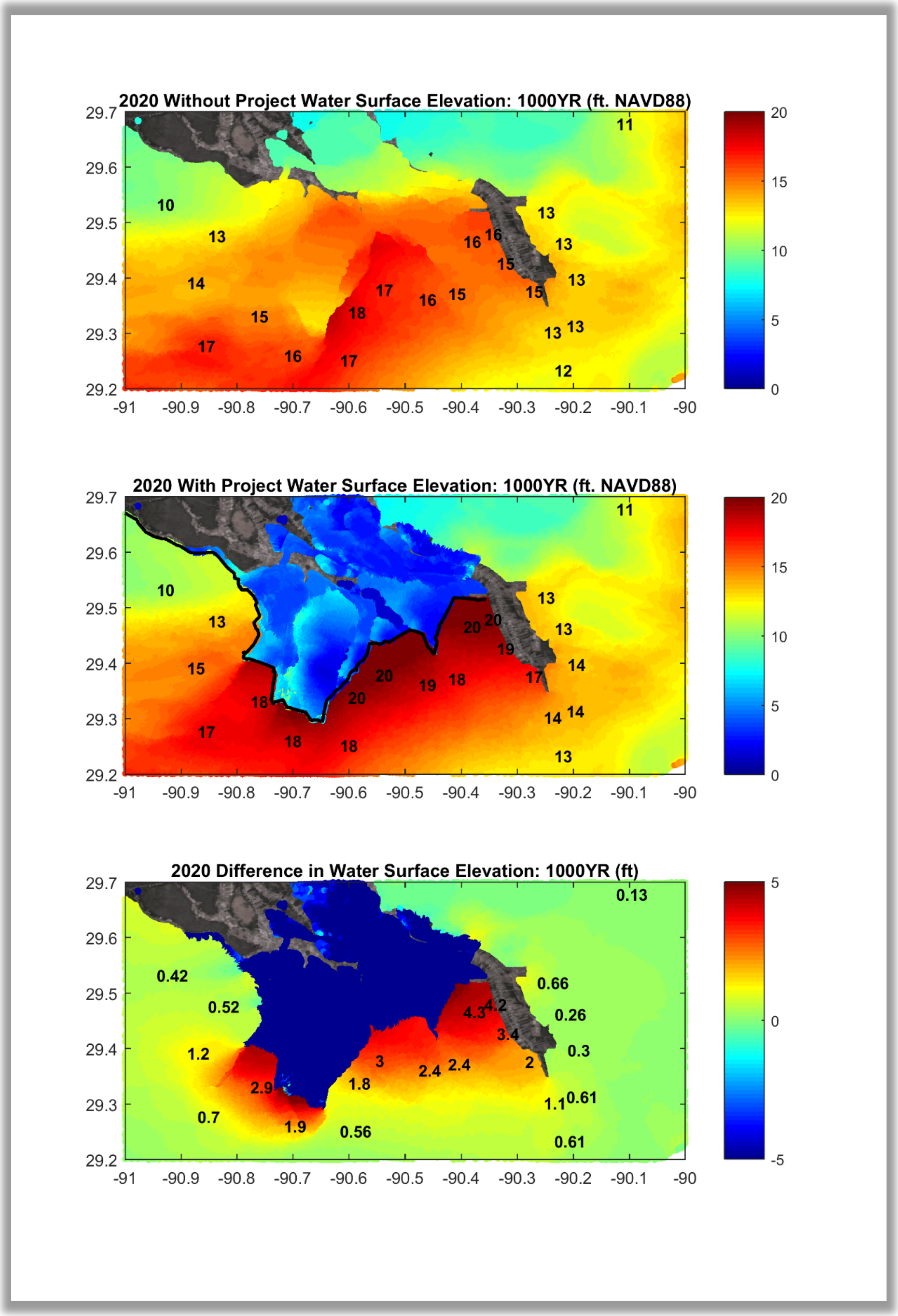


Figure 17-2020 with-and without-project maximum 1000-year stillwater elevations and maximum difference between with-and without-project

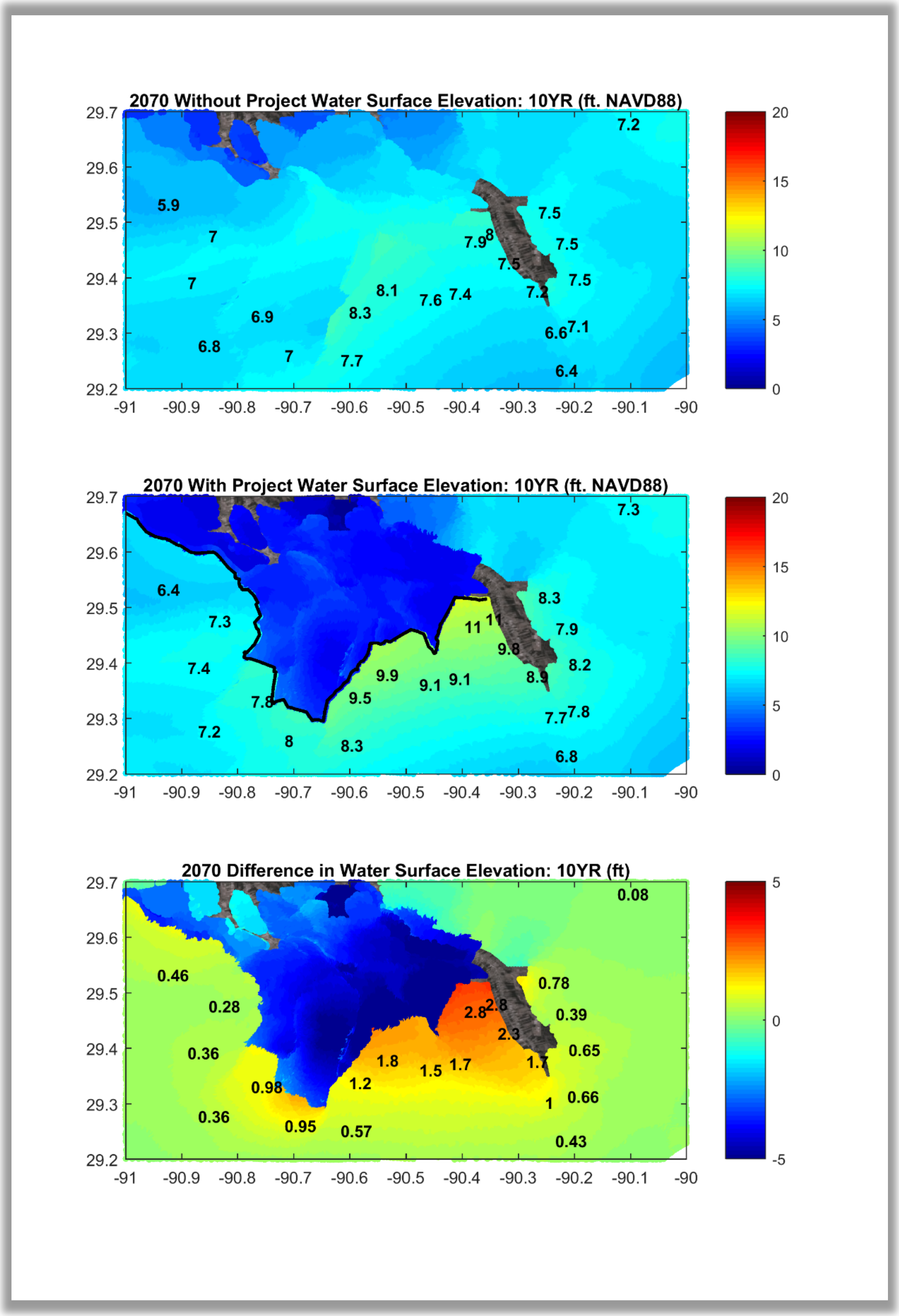


Figure 18-2070 with-and without-project maximum 10-year stillwater elevations and maximum difference between with-and without-project

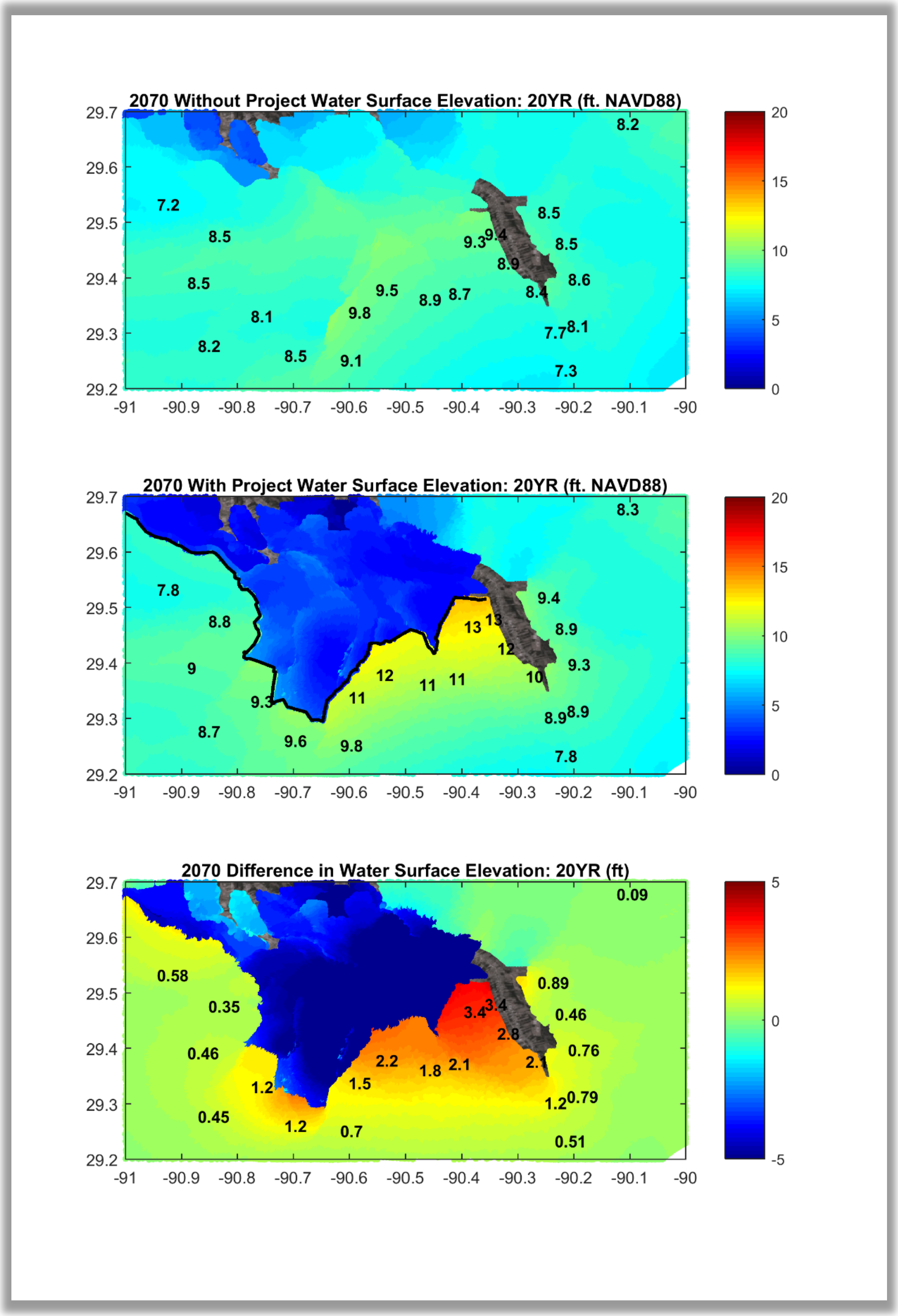


Figure 19-2070 with-and without-project maximum 20-year stillwater elevations and maximum difference between with-and without-project

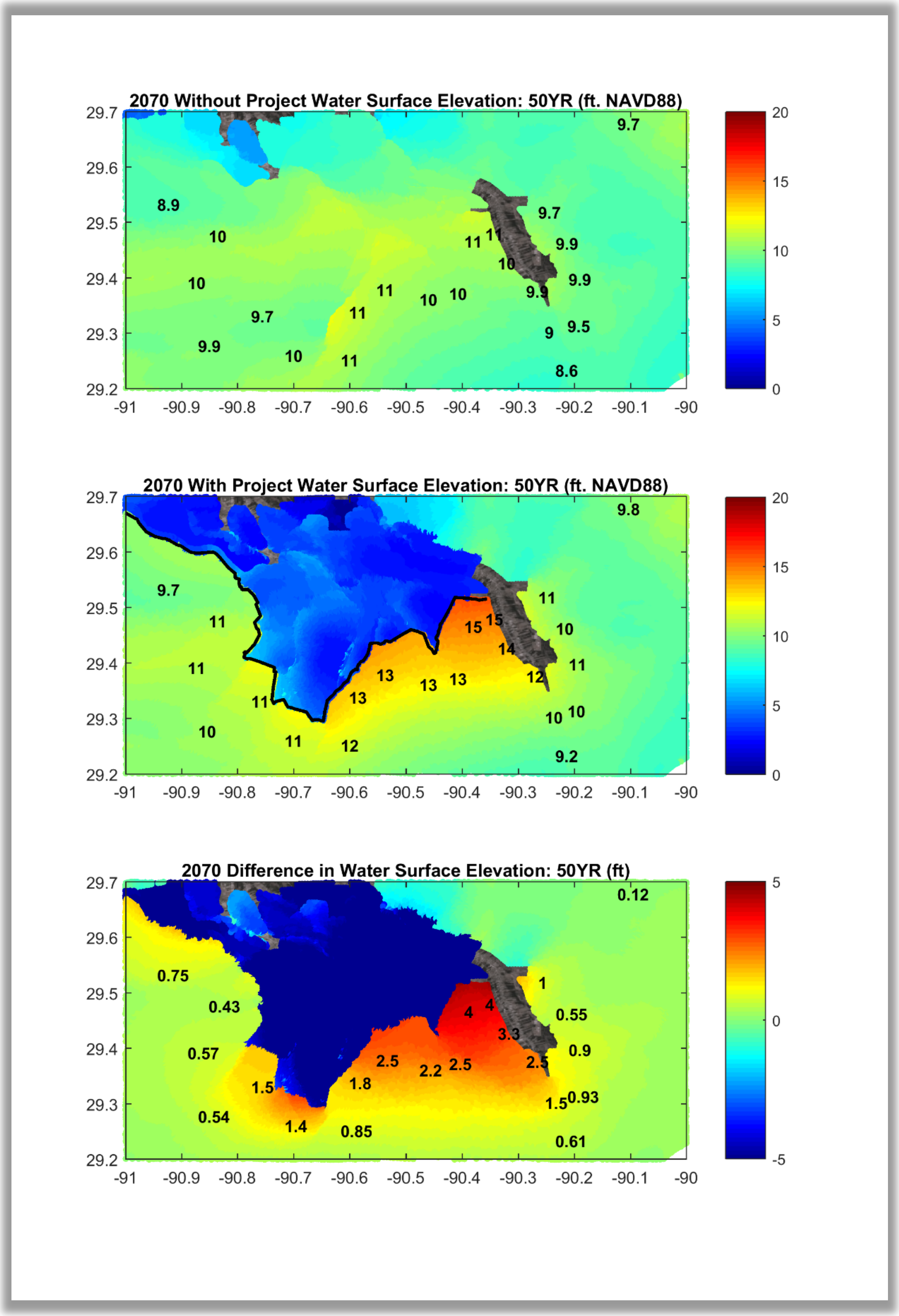


Figure 20-2070 with-and without-project maximum 50-year stillwater elevations and maximum difference between with-and without-project

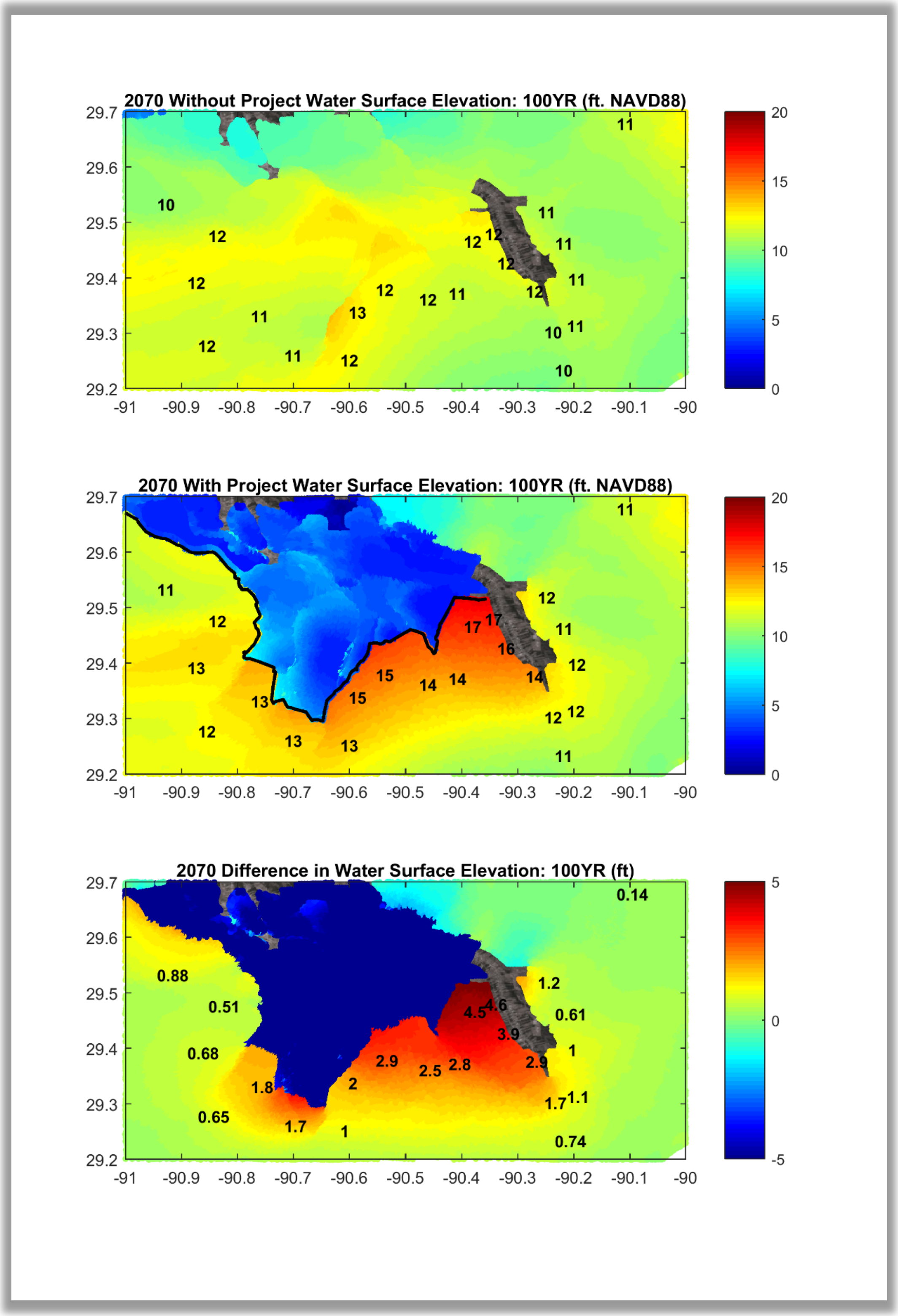


Figure 21-2070 with-and without-project maximum 100-year stillwater elevations and maximum difference between with-and without-project

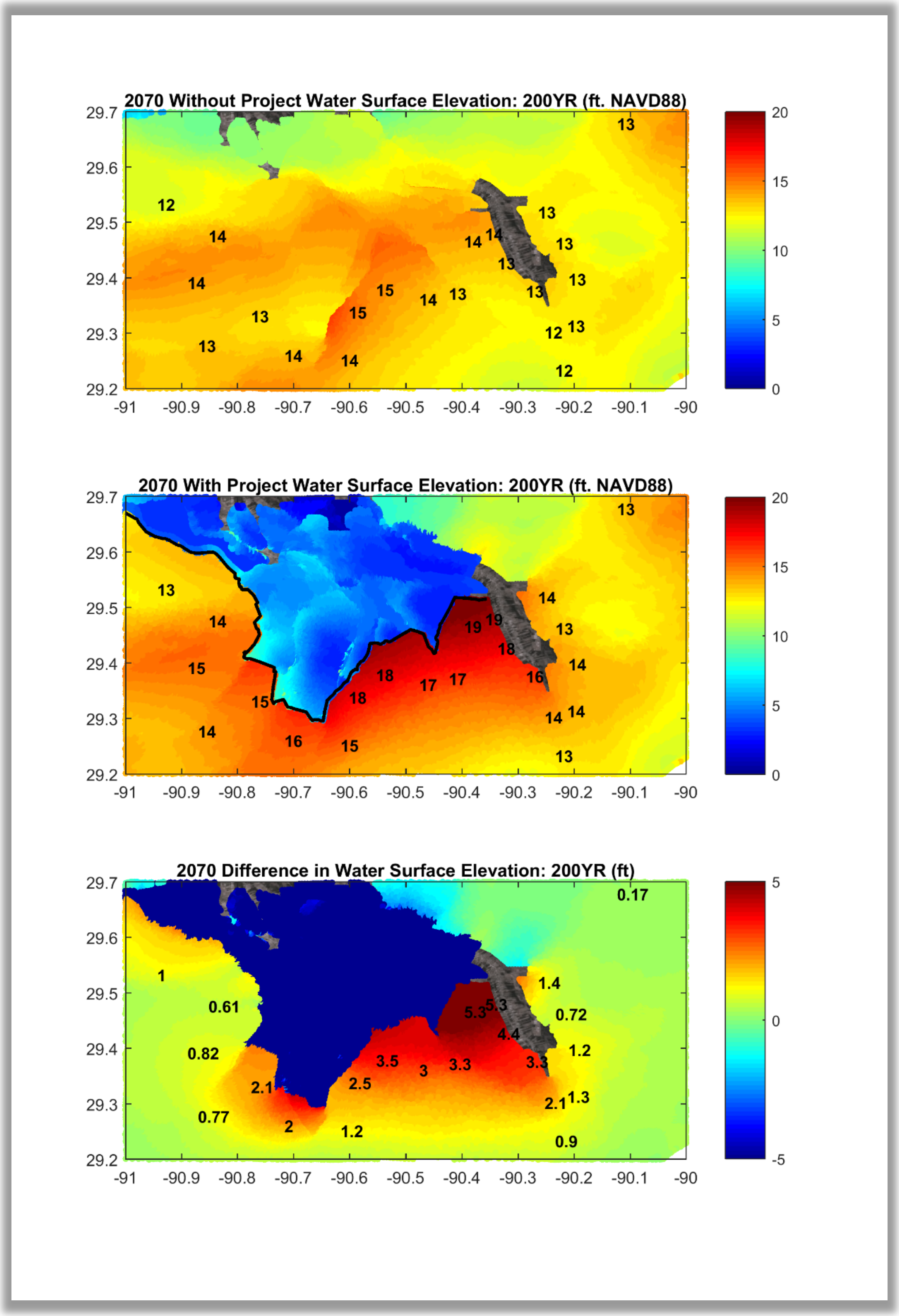


Figure 22-2070 with-and without-project maximum 200-year stillwater elevations and maximum difference between with-and without-project

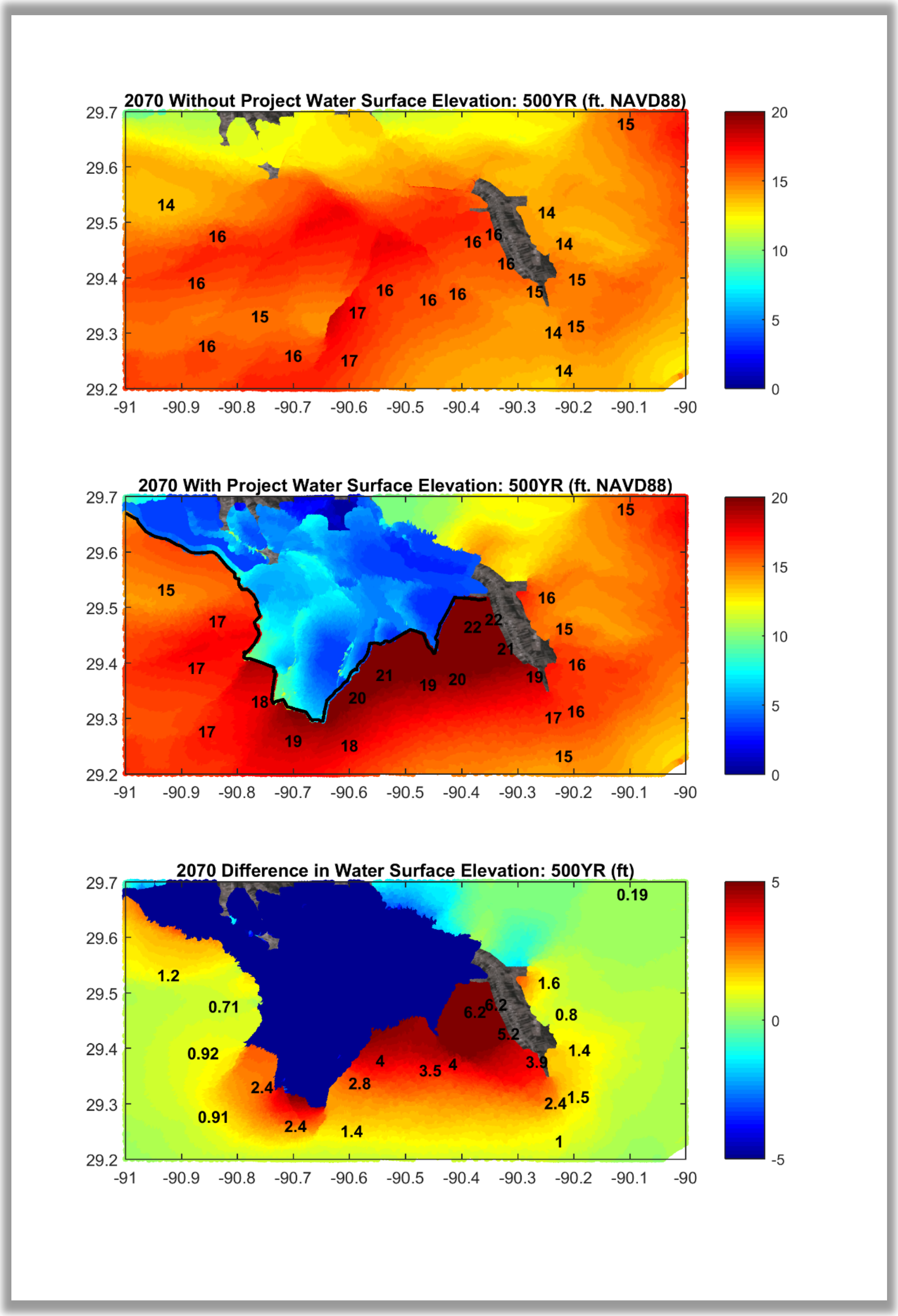


Figure 23-2070 with-and without-project maximum 500-year stillwater elevations and maximum difference between with-and without-project

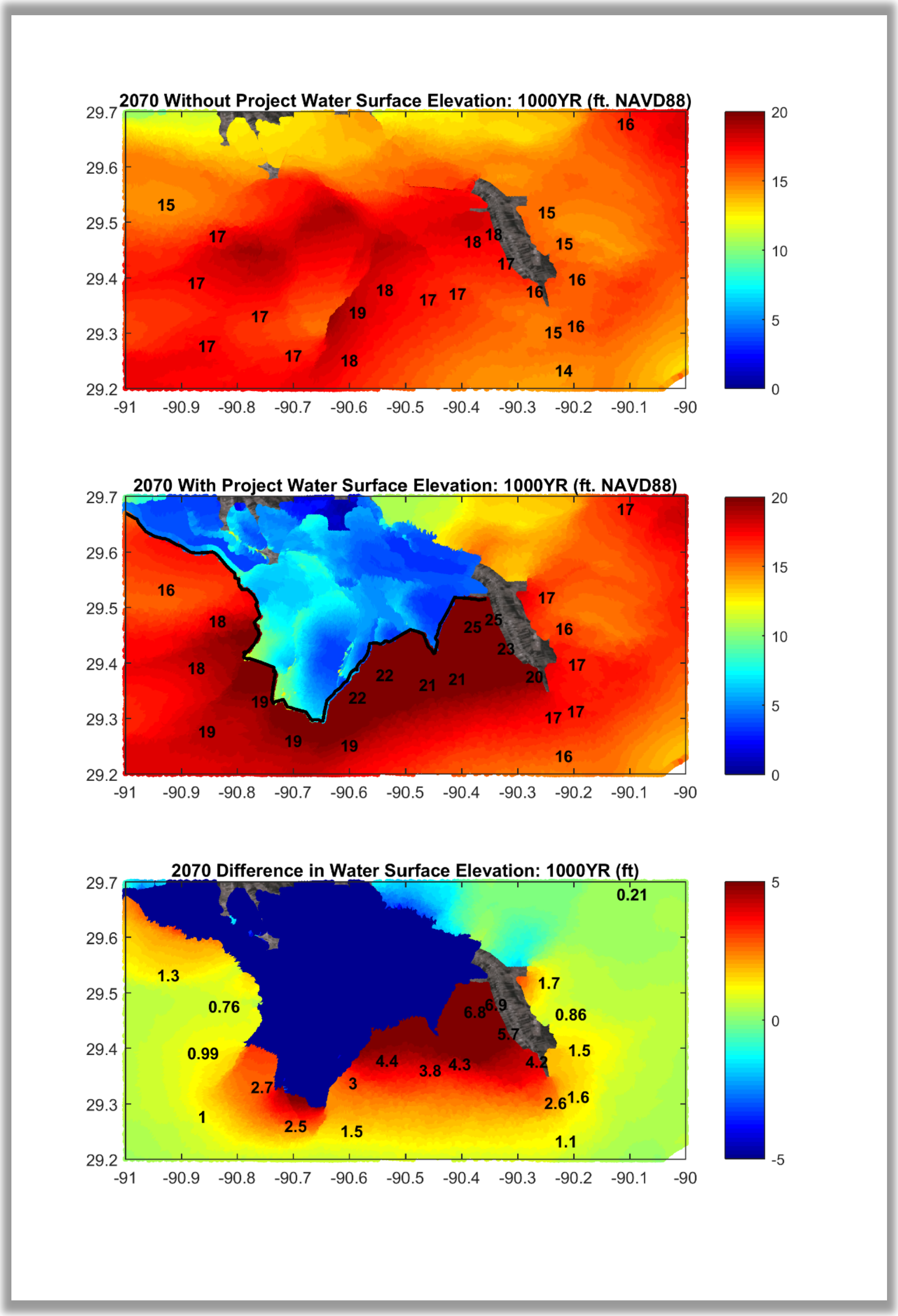


Figure 24-2070 with-and without-project maximum 1000-year stillwater elevations and maximum difference between with-and without-project

2.2 Federal Levee and Structure Design Elevations Methodology

The federal levees and structure elevations were designed for the 1% (100-yr) return period for the Morganza to the Gulf alignment. Design elevations were computed using results from the coupled model for each hydraulic reach (also referred to as a levee construction reach). Figure 1 shows the proposed MTG federal levee alignment and levee reach names.

The hydraulic boundary conditions for each hydraulic reach for the 1% return period for years 2035 and 2085 were obtained from the couples model results presented in Section 2.1 and tabulated in Tables 1 and 2 below where SWE is the stillwater elevation in feet NAVD88(2004.65), Hs is the significant wave height in feet, and Tp is the peak period in seconds.

Design elevations for the future condition scenario are considered to reflect conditions that are likely to exist in the year 2085 due to sea level rise and subsidence. Estimated changes in stillwater elevations in the future year, 2085, are calculated based on 50 years of intermediate relative sea level rise that will occur from the base year, 2035. An intermediate sea level rise rate of 2.42 feet was adopted from the PACR for the analysis.

2035 MTG 1% Existing Conditions Wave and Surge Parameters									
Hydraulic Reach	SWE (ft)	Std. Dev.	Hs (ft)	Tp (s)	Hydraulic Reach	SWE (ft)	Std. Dev.	Hs (ft)	Tp (s)
A-North of GIWW	8.0	1.2	2.1	2.8	I1	14.0	1.4	6.2	5.4
A-South of GIWW	9.0	1.0	2.2	2.6	I2	14.3	1.4	6.9	5.7
B	10.3	1.0	3.8	3.7	I3	14.7	1.4	5.6	5.2
E2	12.6	1.2	5.8	4.8	J2	14.6	1.4	7.0	5.6
E1	12.5	1.2	5.5	4.6	J1	14.7	1.4	6.2	5.4
F2	12.2	1.2	4.5	4.1	K	14.6	1.4	5.9	5.1
F1	12.0	1.2	4.3	3.8	J3	14.2	1.5	5.9	5.2
G1	13.1	1.1	4.9	4.2	L	15.6	1.5	5.0	4.6
G2	13.0	1.1	5.4	4.7	C-North	6.6	1.5	0.8	2.0
G3	12.9	1.1	5.9	4.9	GIWW	6.9	1.2	1.2	2.1
H2	13.5	1.1	5.4	4.8	Lockport -A	7.4	1.2	1.9	2.8
H3	13.8	1.2	6.8	5.3	Lockport -B	5.8	1.2	1.7	2.0
H1	12.5	1.4	4.8	4.3	Barrier	8.2	1.2	2.4	2.8

Table 1 - 1% 2035 hydraulic boundary conditions

2085 MTG 1% Future Conditions Wave and Surge Parameters									
Hydraulic Reach	SWE (ft)	Std. Dev.	Hs (ft)	Tp (s)	Hydraulic Reach	SWE (ft)	Std. Dev.	Hs (ft)	Tp (s)
A-North of GIWW	13.3	1.4	3.0	3.9	I1	16.0	1.6	7.7	6.2
A-South of GIWW	13.3	1.2	3.7	3.5	I2	16.2	1.6	8.3	6.4
B	13.9	1.2	5.6	4.6	I3	16.5	1.6	7.1	6.2
E2	14.5	1.4	7.0	5.2	J2	16.4	1.6	8.3	6.3
E1	14.3	1.4	6.5	5.1	J1	16.4	1.6	7.4	6.0
F2	14.0	1.4	5.7	4.7	K	17.4	1.6	7.9	6.3
F1	13.7	1.4	5.4	4.4	J3	16.0	1.7	7.1	5.9
G1	14.6	1.3	5.9	4.7	L	18.2	1.7	6.0	5.6
G2	14.7	1.3	6.4	5.0	C-North	13.5	1.7	2.2	4.0
G3	14.5	1.3	6.8	5.1	GIWW	12.9	1.4	2.6	3.5
H2	15.6	1.3	6.8	5.6	Lockport -A	10.3	1.4	2.1	3.3
H3	15.8	1.4	8.3	6.0	Lockport -B	8.5	1.4	2.0	2.7
H1	14.2	1.6	5.9	5.0	Barrier	13.9	1.4	3.5	3.8

Table 2 - 1% 2085 hydraulic boundary conditions

Design criteria for the levee and structure elevations also consider wave overtopping limits. Guidelines for establishing the overtopping rate threshold (i.e., the threshold associated with the onset of levee erosion and damage) for different types of embankments can be found in Engineering Manual (EM) 1110-2-1100 (Part VI), Table VI-5-6. These threshold values are consistent with those that are adopted in the EurOtop 2018 Manual on wave overtopping of sea defenses and related structures. The EurOtop manual has overtopping guidance largely based on European research, but for worldwide application. Van der Meer, J.W., Allsop, N.W.H., Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P. and Zanuttigh, B., www.overtopping-manual.com. (December 2018). The following wave overtopping rates have been established for the Morganza to the Gulf hurricane protection system:

- For the design water surface elevation, wave height and wave period, the maximum allowable average wave overtopping

  of 0.5 cubic feet per second per foot (cfs/ft) at 90% level of assurance for grass covered levees.
- For the design water surface elevation, wave height and wave period, the maximum allowable average wave overtopping of 0.5 cfs/ft at 90% level of assurance for floodwalls with appropriate protection on the back side.

The application of a Monte Carlo analysis is then used to determine the overtopping rate with a Matlab script for overtopping. The probabilistic overtopping formulations from EurOtop are applied for the levees. Besides the geometric parameters (levee height and slope), hydraulic input parameters for determination of the overtopping rate in Equation 1 and 2 are the water elevation (ζ), the spectral wave height (Hm0) and the spectral wave period (Tm). Reference the figure below for equation 1. The EurOtop overtopping formula is shown below.

The general formula for the average overtopping discharge on a slope (dike, levee, and embankment) are given by the mean value approach in equation 1:

$$\frac{q}{\sqrt{g \cdot H_{m0}^3}} = \frac{0.023}{\sqrt{\tan\alpha}} \gamma_b \cdot \xi_{m-1,0} \cdot \exp[-(2.7 \frac{R_c}{\xi_{m-1,0} \cdot H_{m0} \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma_v})^{1.3}]$$

with a maximum of

$$\frac{q}{\sqrt{g \cdot H_{m0}^3}} = 0.09 \cdot \exp[-(1.5 \frac{R_c}{H_{m0} \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma *})^{1.3}]$$

Equation 1

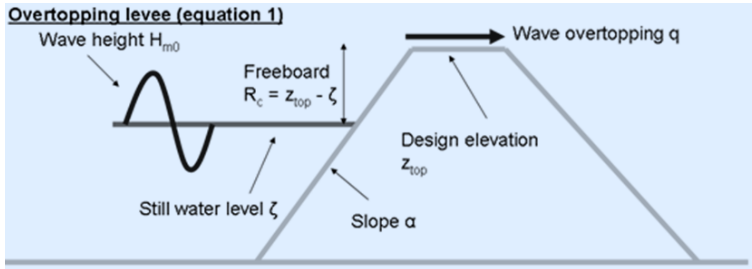
The mean value approach for the vertical wall is given by equation 2:

$$\frac{q}{\sqrt{g \cdot H_{m0}^3}} = 0.047 \cdot \exp[-(2.35 \frac{R_c}{H_{m0} \cdot \gamma_f \cdot \gamma_\beta})^{1.3}]$$

Equation 2

with:
q : average overtopping rate [cfs/ft],
g : gravitational acceleration [ft/s2],
Hm0 : wave height at toe of the structure [ft],
ξm-1,0: breaker parameter [-],
α : slope [-],
Rc : freeboard [ft],
γ : coefficient for presence of berm (b), friction (f), wave incidence (β), vertical wall (v),

Equations 1 and 2 show quite a number of influence factors: γb is the influence factor for a berm [-], γf is the influence factor for roughness elements on a slope [-], γβ is the influence factor for oblique wave attack [-] and γv is the influence factor for a wall at the end of a slope. Compared to EurOtop (2007), an influence factor γ* [-] has been added for non-breaking waves (relatively steep slopes) for a storm wall on a slope or promenade. ξm-1,0, the breaker parameter, or surf similarity parameter, relates the slope steepness tan α to the wave steepness sm-1,0 and is often used to distinguish different breaker types. For relatively gentle slopes, the breaker parameter is generally smaller than ξm-1,0= 4. In case larger values are found for slopes of 1:2.5 or gentler, this can only be due to very small wave steepness, probably caused by severe wave breaking on a very shallow foreshore. Steep slopes of 1:2 up to vertical walls, give less wave run-up and wave overtopping. Wave steepness is defined as the ratio of wave height to wavelength (e.g. s0 = Hm0/L0). The breaker parameter, surf similarity or Iribarren number is defined as ξm-1,0 = tanα/(Hm0/Lm-1,0)½, where α is the slope of the front face of the structure and Lm-1,0 being the deep water wave length gT2 m-1,0/(2π).



Overtopping levee (Equation 1)

The Monte Carlo Analysis is executed as follows:

1. Draw a random number between 0 and 1 to set the exceedance probability (p).
2. Compute the water elevation from a normal distribution using the mean 1% surge elevation and standard deviation as parameters and with an exceedance probability (p).
3. Draw a random number between 0 and 1 to set the exceedance probability (p).
4. Compute the wave height and wave period from a normal distribution using the mean 1% wave height/wave period and associated standard deviation and with an exceedance probability (p).
5. Repeat steps 3 and 4 for the three overtopping coefficients independently.
6. Compute the overtopping rate for these hydraulic parameters and overtopping coefficients determined in steps 2, 4 and 5 using the EurOtop overtopping formulations for levees and floodwalls as referenced in equations 1 and 2).
7. Repeat steps 1 through 5 many times (N).
8. Compute the 50% and 90% confidence limit of the overtopping rate. (i.e. q50 and q90).

The resulting levee design elevations, produced using the Hurricane Storm Damage Risk Reduction System (HSDRRS) guidelines for earthen levees without-wave berms, and an overtopping rate threshold of q90 = 0.5 cfs/ft for levees with a 1V:6H slope for the base and future year are contained in Tables 3 and 4 below. Elevations are referenced to NAVD88(2004.65).

2035 MTG 1% Base Year Design Elevations			
Hydraulic Reach	Levee Elevation (ft)	Hydraulic Reach	Levee Elevation (ft))
A-North of GIWW	12.0	I1	20.0
A-South of GIWW	13.5	I2	21.0
B	15.0	I3	20.0
E2	18.0	J2	21.5
E1	18.0	J1	20.5
F2	17.5	K	20.5
F1	17.0	J3	20.0
G1	19.0	L	20.5
G2	19.0	C-North	14.0
G3	19.0	GIWW	13.0

H2	19.0	Lockport -A	10.0
H3	20.0	Lockport-B	8.5
H1	18.5	Barrier	12.0

Table 3 - % 2035 hydraulic levee design elevations (0.5cfs/ft overtopping)

2085 MTG 1% Future Year Design Elevations			
Hydraulic Reach	Levee Elevation (ft)	Hydraulic Reach	Levee Elevation (ft))
A-North of GIWW	17.0	I1	24.0
A-South of GIWW	18.0	I2	25.0
B	18.5	I3	24.5
E2	21.0	J2	25.0
E1	20.0	J1	24.0
F2	19.0	K	26.0
F1	18.5	J3	23.5
G1	20.0	L	24.5
G2	20.5	C-North	16.5
G3	20.5	GIWW	16.0
H2	22.0	Lockport -A	14.0
H3	24.0	Lockport-B	12.0
H1	20.0	Barrier	18.0

Table 4 -1% 2085 hydraulic levee design elevations (0.5cfs/ft overtopping)

The design elevations in Tables 3 and 4 vary by levee reach because of surge and wave differences due to storm path, wind speeds and direction, etc. Hydraulic structure design elevations are the same as the levee elevations when considering elevations for structures. If structures are in the middle of a hydraulic reach with varying heights, the higher elevation of the two reaches should be used to determine the required structure height to satisfy hydraulic design requirements.

2.3 Interior and Exterior Stillwater Frequency Curves

Storm surge stillwater frequency curves for the interior and exterior were derived using the results of the coupled ADCIRC + SWAN model for each economic reach within the study area for use in computing a benefit cost ratio in the HEC-FDA model. The stage frequency curves include eight annual chance exceedance (ACE) events: 99% (1-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year), 0.5% (200-year), and 0.2% (500-year) as shown in tables 5 through 16. Elevations are referenced to NAVD88(2004.65).

Interior stage frequency curves were developed for without-project conditions for the base year 2035 and future year 2085 for each of the 266 economic reaches within the study area as shown in Figure 25. Using the ADCIRC + SWAN output values stillwater elevations for year 2085 were linearly extrapolated from the 2070 values; stillwater elevations for the base year 2035 were interpolated from the results of the 2020 and 2070 model results. Values for returns lower than the 10-year were also extrapolated; values for the 25-year were interpolated using the 20- and 50-year values.

Similarly, the exterior frequency curves were also developed for each reach for with-project conditions as shown in Tables 10 through 16. Stillwater elevations are in NAVD88 epoch 2004.5. Each interior reach was associated with an exterior stillwater stage, based location along the proposed federal levee. The exterior stages represent the stage in which the water will rise in the interior due to a federal levee breach. The without-project interior stage frequency data does not include the effects of rainfall, wave overtopping, pumping, or levee breaching. The values represent stillwater levels in the study area before the construction of the federal levee system due to storm surge as modeled in the coupled model. The with-project exterior stage frequency data does not include the effects of rainfall, wave overtopping, pumping, or levee breaching. The values represent predicted stillwater levels along the exterior of the proposed levee system. The with-and without-project curves were used in HEC-FDA to compute the project benefits. Reference Section 2.5 for more details.

Figure 25-MTG economic reach map

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

2035 MTG Without-Project Interior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
1-1AB	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**4-2**	1.55	3.00	4.70	6.75	9.00	10.80	12.60	14.90
1-1AN	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**4-2A**	1.55	3.00	4.70	6.75	9.00	10.80	12.60	14.90
11BE1	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**4-2B**	1.50	2.70	4.20	6.82	9.90	11.50	13.70	15.60
11BE2	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**4-2C**	1.50	2.70	4.20	6.73	9.90	11.40	13.30	15.10
11BE3	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**4-7**	1.33	2.70	4.17	5.67	7.00	8.30	9.80	11.60
11BE4	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**4MGT**	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40
11BE5	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**5-1A**	1.50	2.90	4.60	6.60	8.60	10.40	12.40	14.70
11BE6-E	1.15	2.40	3.60	4.97	6.30	7.30	8.50	10.00	**5-1B**	1.50	2.90	4.60	6.77	9.10	11.00	12.90	15.50
11BE6-W	1.15	2.50	3.63	4.93	6.10	7.10	8.20	9.70	**6-1B1**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-1BU3-U1	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70	**6-1B1-B**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-1BU3-U2	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70	**8-1N**	1.55	3.10	4.86	6.62	8.20	9.90	11.80	14.10
1-1BU3-U3	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70	**8-1N-B**	1.55	3.10	4.86	6.62	8.20	9.90	11.80	14.10
11BU4	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**8-1S-B**	1.53	3.10	4.78	6.52	8.10	10.00	11.70	13.90
11BW11	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**8-2C**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
11BW2-W1	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**8-2D**	1.70	3.50	5.63	7.57	8.90	10.20	12.10	14.40
11BW2-W2	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**9-1AE**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW4-W3	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**9-1AMID**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW4-W4	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**9-1AW**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW4-W4A	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**9-1BE**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW5	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**9-1BMIDE**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW6	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**9-1BMIDW**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW79	1.15	2.50	3.63	4.93	6.10	7.10	8.20	9.70	**9-1BW**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
11BW79-W7	0.81	2.07	2.78	3.87	5.20	6.90	8.20	9.50	**A1**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-2MID	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**B1**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-2N	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**BB1**	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40
1-2S	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80	**BB2**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
1-3	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80	**BB3**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-5	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**BB4**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-7_N3-4	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BB5**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-7_N4-7	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BB6**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-7_N7-10	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BB7**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
1-7-N10-13	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BB8-B**	1.10	2.40	3.50	4.82	5.90	7.00	8.30	10.00
1-7N13-16	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BD1**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
1-7N16-17	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BDL0**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
1-7N17-24	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BDL1**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
1-7N24-28	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BDL2**	1.55	3.10	4.86	6.58	8.00	9.70	11.60	14.00
1-8	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BDL3**	1.70	3.50	5.63	7.57	8.90	10.20	12.10	14.40
2-1A2	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**BDL4**	1.58	3.00	4.90	6.67	8.00	9.70	11.70	13.80
2-1B2-MID	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**BDL4-B**	1.58	3.00	4.90	6.67	8.00	9.70	11.70	13.80
2-1B2N	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**BDL5**	1.53	3.00	4.70	6.50	8.00	9.80	11.90	14.00
2-1B2S	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**BGC0**	1.43	2.90	4.47	6.17	8.00	9.80	11.70	14.30
3-1B	1.43	2.80	4.40	6.13	7.80	9.50	11.30	13.40	**BGC1**	1.60	3.20	5.01	6.80	8.30	10.00	11.90	14.50
3-1C	1.70	3.50	5.55	7.47	8.80	10.20	11.80	14.30	**BGC2**	1.60	3.20	5.01	6.83	8.50	10.30	12.10	14.70
4-1N	1.70	3.60	5.48	7.40	8.90	10.60	12.40	14.30	**BGC3**	1.70	3.50	5.55	7.47	8.80	10.10	11.80	14.20
4-1S	1.80	4.00	6.63	8.82	9.90	11.30	13.40	15.30	**BGC4**	1.60	3.40	5.32	7.15	8.40	9.70	11.50	13.60

Table 5-2035 without-project interior frequency curves (feet NAVD88 epoch 2004.65)

2035 MTG Without-Project Interior Frequency Curves

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

Economic Reach	0.999	0.2	0.1	0.04	0.02	0.01	0.005	0.002	Economic Reach	0.999	0.2	0.1	0.04	0.02	0.01	0.005	0.002
BL1	0.83	2.10	2.85	3.88	4.80	5.70	7.70	9.70	**D-26**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
BL2	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70	**D-28**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BL3	0.81	2.07	2.78	3.73	4.40	5.20	7.40	9.60	**D-29**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BL4	0.81	2.07	2.78	3.75	4.50	5.30	7.80	9.80	**D-30**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BL5	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70	**D-31**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BL6	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70	**D-34N**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BL7	0.86	2.10	2.93	4.03	5.20	7.20	8.40	9.90	**D-34S**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BL89	1.03	2.30	3.32	4.55	5.80	7.10	8.90	10.40	**D-35**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BPC1	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**D-36**	1.60	3.20	5.01	6.83	8.50	10.30	12.10	14.70
BPC2	1.50	2.90	4.60	6.77	9.10	10.90	12.80	15.20	**D-37**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
BPC3	1.50	2.70	4.20	6.82	9.90	11.50	13.70	15.60	**D-38**	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80
BPC4	1.50	2.70	4.20	6.73	9.90	11.40	13.30	15.10	**D-39-1**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
BPC5	1.45	3.00	4.55	6.18	7.60	9.20	10.90	12.90	**D-39-2**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
BPC5-B	1.45	3.00	4.55	6.18	7.60	9.20	10.90	12.90	**D-39-3**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
BT1	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**D-42**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BT10	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**D-43**	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80
BT2	1.55	3.00	4.70	6.75	9.00	10.80	12.60	14.90	**D-44**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BT3	1.33	2.70	4.17	5.67	7.00	8.30	9.80	11.60	**D-45**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BT4	1.50	2.90	4.60	6.87	9.20	10.90	12.90	15.10	**D-48**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BT4-SA	1.80	4.00	6.48	8.65	9.90	11.30	13.40	15.40	**D-49**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BT5	1.50	2.60	4.10	6.73	9.90	11.40	13.40	15.20	**D-50**	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80
BT5-B	1.50	2.60	4.10	6.73	9.90	11.40	13.40	15.20	**D-51**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
BT6	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**D-53**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
BT6A	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**D-56**	1.50	2.60	3.90	6.75	10.00	11.60	13.60	15.50
BT7	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**D-60**	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80
BT8	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**D-61**	1.70	3.70	5.94	7.98	9.40	10.90	13.00	15.10
BT9	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**D-61-B**	1.70	3.70	5.94	7.98	9.40	10.90	13.00	15.10
C1	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**D-62-B**	1.23	2.60	3.86	5.23	6.40	7.90	9.90	11.90
C1-LF	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**D-64**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
CC1	1.20	2.60	3.78	5.15	6.40	7.70	9.10	10.80	**E1**	1.10	2.40	3.50	4.82	5.90	7.00	8.30	10.00
D-01	1.70	3.60	5.94	7.98	9.40	10.70	12.50	14.60	**E1-LF**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
D-06	1.45	3.00	4.55	6.18	7.60	9.20	10.90	12.90	**E1-LF-B**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
D10	1.60	3.40	5.32	7.15	8.40	9.80	11.50	13.80	**E2**	1.18	2.50	3.70	5.03	6.20	7.50	9.00	10.90
D-16N	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**E2-B**	1.18	2.50	3.70	5.03	6.20	7.50	9.00	10.90
D-16S	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**E2-LF**	1.18	2.50	3.70	5.03	6.20	7.50	9.10	10.90
D-1732	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**E2-LF-B**	1.18	2.50	3.70	5.03	6.20	7.50	9.10	10.90
D1A	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**FC**	1.70	3.60	5.71	7.65	8.90	10.20	12.00	14.40
D1B	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**GW10**	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40
D1b-LF	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**GW11**	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40
D1C	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**GW12**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
D1c-LF1	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**GW13**	1.15	2.40	3.60	4.97	6.30	7.30	8.50	10.00
D1c-LF2	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**GW14**	1.18	2.10	3.00	5.08	6.50	7.70	9.00	10.90
D1c-LF3	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**GW14-1**	1.18	2.10	3.00	5.08	6.50	7.70	9.00	10.90
D-25	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40	**GW15**	1.18	2.40	3.70	5.07	6.40	7.60	8.80	10.50
D-25-B	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40	**GW16**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60

Table 6-2035 without-project interior frequency curves (feet NAVD88 epoch 2004.65)

2035 MTG Without-Project Interior Frequency Curves																	
Economic	0.999	0.2	0.1	0.04	0.02	0.01	0.005	0.002	Economic	0.99	0.2	0.1	0.04	0.02	0.01	0.005	0.002

Reach									Reach	9							
GW17	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80	**LL1**	1.25	2.60	3.93	5.37	6.70	8.00	9.50	11.20
GW18	1.23	2.60	3.86	5.23	6.40	7.90	9.90	11.90	**LL2**	1.25	2.70	3.93	5.37	6.70	8.00	9.50	11.20
GW18-B	1.23	2.60	3.86	5.23	6.40	7.90	9.90	11.90	**LL3**	1.30	2.70	4.09	5.63	7.30	8.60	10.10	11.80
GW2	1.33	2.70	4.17	5.67	7.00	8.30	9.80	11.60	**MC1**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
GW3	1.33	2.70	4.17	5.67	7.00	8.30	9.80	11.60	**OB1**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
GW4	1.38	2.80	4.32	5.90	7.40	8.80	10.40	12.20	**OB2**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
GW5	1.50	2.90	4.60	6.62	8.20	9.50	11.20	13.10	**OB3**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
GW6	1.50	2.90	4.70	6.73	8.40	9.80	11.50	13.40	**OB4**	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40
GW7	1.20	2.30	3.50	5.33	7.50	9.00	10.50	12.20	**PAC1**	1.60	3.40	5.70	7.93	9.60	11.10	13.00	14.90
GW8	1.03	2.30	3.32	4.55	5.80	7.10	8.90	10.40	**SL1**	1.60	3.30	5.17	6.93	8.10	9.40	11.00	12.60
GW9	1.45	2.90	4.55	6.23	7.90	9.20	11.00	12.90	**SL2**	1.60	3.40	5.40	7.30	8.80	10.30	12.00	13.90
HC1	1.08	2.40	3.47	4.75	6.00	7.10	8.20	9.60	**SL3**	1.70	3.50	5.79	7.82	9.40	10.90	12.90	14.80
HC2	1.05	2.40	3.39	4.65	5.90	7.10	8.20	9.60	**TS1**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HC3	1.18	2.60	3.70	5.03	6.20	7.40	8.70	10.40	**TS10**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HC4	1.15	2.60	3.63	4.93	6.10	7.30	8.60	10.10	**TS11**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC0	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80	**TS12**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC1	1.40	2.90	4.40	6.03	7.70	9.40	11.20	13.40	**TS13**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC10	1.58	3.20	4.94	6.62	7.70	9.20	11.10	13.20	**TS14**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC10-B	1.58	3.20	4.94	6.62	7.70	9.20	11.10	13.20	**TS15**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC2	1.55	3.10	4.86	6.58	8.00	9.70	11.60	14.00	**TS16**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC3	1.70	3.50	5.63	7.57	8.90	10.10	12.00	14.40	**TS17**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC4	1.70	3.50	5.63	7.57	8.90	10.20	11.90	14.40	**TS18**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC5	1.60	3.20	5.01	6.80	8.30	10.00	11.90	14.50	**TS19**	1.05	2.40	3.39	4.65	5.90	7.10	8.20	9.60
HNC6	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80	**TS2**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC7	1.43	2.90	4.47	6.13	7.80	9.60	11.40	13.80	**TS20**	1.05	2.40	3.39	4.65	5.90	7.10	8.20	9.60
HNC8	1.60	3.40	5.40	7.25	8.50	9.80	11.60	13.80	**TS21**	1.05	2.40	3.39	4.65	5.90	7.10	8.20	9.60
HNC9	1.70	3.60	5.55	7.40	8.40	9.70	11.40	13.60	**TS22**	1.05	2.40	3.39	4.65	5.90	7.10	8.20	9.60
HNC9-B	1.70	3.60	5.55	7.40	8.40	9.70	11.40	13.60	**TS3**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC9-E	1.70	3.60	5.48	7.32	8.40	9.80	11.50	13.70	**TS4**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
HNC9-W	1.70	3.50	5.55	7.45	8.70	10.00	11.70	14.10	**TS5**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
LB1	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**TS6**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
LB2	1.50	2.90	4.50	6.52	8.60	10.50	12.40	14.80	**TS7**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
LB3	1.50	2.90	4.60	6.80	8.80	10.60	12.40	14.90	**TS9**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
LB4	1.58	3.00	4.70	6.80	8.80	10.60	12.40	15.00	**US1**	0.81	2.07	2.78	3.73	4.40	5.30	7.70	9.70
LB5	1.43	2.80	4.40	6.13	7.80	9.50	11.30	13.40	**GW11-B**	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40
LBB2	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**E1-B**	1.10	2.40	3.50	4.82	5.90	7.00	8.30	10.00
LBB3	1.20	2.60	3.78	5.17	6.50	7.80	9.30	11.40	**BB7-B**	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60
LBB4	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**BD1-B**	1.23	2.50	3.86	5.27	6.60	8.20	10.20	12.60
LBB5	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**BC**	0.98	2.20	3.16	4.73	7.90	9.60	11.50	13.50
LBB6	0.78	1.94	2.62	3.60	4.60	5.80	7.50	8.60	**L2L-A**	1.25	2.89	3.93	5.33	6.50	8.20	9.80	11.20
LBC1	1.23	2.60	3.86	5.27	6.60	8.10	10.10	12.40	**L2L-B**	0.98	2.32	3.16	4.33	5.50	6.70	8.20	9.60
LBC2	1.80	4.40	7.17	9.53	10.70	12.00	14.20	16.30									
LF1	1.03	2.30	3.30	4.60	6.10	7.30	8.40	9.80									
LF2	1.03	2.30	3.30	4.60	6.10	7.30	8.40	9.80									
LF-GB	1.60	3.40	5.60	7.70	9.20	10.30	11.80	14.00									

Table 7-2035 without-project interior frequency curves (feet NAVD88 epoch 2004.65)

2085 MTG Without-Project Interior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
1-1AB	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**4-2**	3.27	5.70	8.32	10.42	11.50	13.10	15.00	17.40
1-1AN	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**4-2A**	3.27	5.70	8.32	10.42	11.50	13.10	15.00	17.40

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

11BE1	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**4-2B**	3.40	6.10	8.90	10.93	11.60	13.20	15.40	17.80
11BE2	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**4-2C**	3.40	6.20	8.82	10.75	11.00	12.50	14.60	16.90
11BE3	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**4-7**	2.60	5.20	7.30	9.32	10.40	11.70	13.60	15.20
11BE4	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**4MGT**	2.78	5.00	7.40	9.62	11.20	12.70	14.20	16.00
11BE5	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**5-1A**	3.14	5.50	7.99	10.05	11.30	13.00	14.60	17.20
11BE6-E	2.16	4.70	6.30	8.13	9.30	10.40	12.00	14.00	**5-1B**	3.30	5.80	8.65	10.75	12.00	13.60	15.40	18.20
11BE6-W	2.11	4.58	6.14	7.93	9.10	10.30	11.80	13.80	**6-1B1**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
1-1BU3-U1	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50	**6-1B1-B**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
1-1BU3-U2	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50	**8-1N**	2.84	5.25	7.66	9.70	11.20	12.85	14.95	17.05
1-1BU3-U3	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50	**8-1N-B**	2.84	5.25	7.66	9.70	11.20	12.85	14.95	17.05
11BU4	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**8-1S-B**	2.75	5.20	7.49	9.47	10.80	12.40	14.40	16.10
11BW11	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**8-2C**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20
11BW2-W1	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**8-2D**	2.87	5.30	7.82	9.90	11.40	13.10	15.40	17.60
11BW2-W2	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**9-1AE**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW4-W3	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**9-1AMID**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW4-W4	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**9-1AW**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW4-W4A	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**9-1BE**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW5	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**9-1BMIDE**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW6	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**9-1BMIDW**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW79	2.11	4.58	6.14	7.93	9.10	10.30	11.80	13.80	**9-1BW**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
11BW79-W7	2.19	4.70	6.38	8.22	9.30	10.10	11.60	13.60	**A1**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
1-2MID	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**B1**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
1-2N	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**BB1**	2.78	5.00	7.40	9.62	11.20	12.70	14.20	16.00
1-2S	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30	**BB2**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
1-3	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30	**BB3**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
1-5	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**BB4**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
1-7_N3-4	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BB5**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
1-7_N4-7	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BB6**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
1-7_N7-10	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BB7**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
1-7-N10-13	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BB8-B**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
1-7N13-16	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BD1**	2.78	5.05	7.45	9.56	11.10	12.50	14.30	16.30
1-7N16-17	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BDL0**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20
1-7N17-24	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BDL1**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20
1-7N24-28	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BDL2**	2.90	5.40	7.90	10.00	11.50	12.90	14.80	17.40
1-8	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BDL3**	2.87	5.30	7.82	9.90	11.40	13.10	15.40	17.60
2-1A2	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**BDL4**	2.75	5.25	7.49	9.48	10.90	12.70	14.80	16.60
2-1B2-MID	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**BDL4-B**	2.75	5.25	7.49	9.48	10.90	12.70	14.80	16.60
2-1B2N	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**BDL5**	3.14	5.40	7.99	10.08	11.50	13.00	15.10	17.10
2-1B2S	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**BGC0**	3.27	5.60	8.32	10.48	11.90	13.50	15.00	18.00
3-1B	2.75	5.30	7.49	9.45	10.70	12.20	13.80	16.10	**BGC1**	3.17	5.50	8.07	10.22	11.80	13.40	15.00	18.00
3-1C	2.78	5.20	7.57	9.62	11.20	12.80	14.60	17.10	**BGC2**	3.17	5.50	8.07	10.18	11.60	13.30	15.00	17.90

4-1N	2.87	5.40	7.82	9.85	11.10	12.60	14.70	16.70	**BGC3**	2.75	5.20	7.49	9.52	11.10	12.70	14.60	17.10
4-1S	3.17	5.60	8.07	10.17	11.50	13.10	15.50	17.80	**BGC4**	2.51	5.10	7.06	9.10	10.60	12.20	14.00	16.20

Table 8-2085 without-project interior frequency curves (feet NAVD88 epoch 2004.65)

2085 MTG Without-Project Interior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
BL1	2.30	4.80	6.70	8.67	10.00	11.20	12.40	14.20	**D-26**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20
BL2	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50	**D-28**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BL3	2.30	4.70	6.70	8.70	10.20	11.60	12.80	14.60	**D-29**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BL4	2.46	4.80	6.90	8.90	10.40	11.70	12.80	14.70	**D-30**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BL5	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50	**D-31**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BL6	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50	**D-34N**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BL7	2.46	4.90	6.90	8.88	10.30	11.10	12.60	14.70	**D-34S**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BL89	2.27	4.70	6.62	8.65	10.40	11.80	13.70	15.50	**D-35**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BPC1	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**D-36**	3.17	5.50	8.07	10.18	11.60	13.30	15.00	17.90
BPC2	3.30	5.80	8.57	10.63	11.80	13.40	15.20	17.80	**D-37**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20
BPC3	3.40	6.10	8.90	10.93	11.60	13.20	15.40	17.80	**D-38**	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30
BPC4	3.40	6.20	8.82	10.75	11.00	12.50	14.60	16.90	**D-39-1**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
BPC5	2.51	5.05	7.06	9.05	10.30	11.75	13.55	15.80	**D-39-2**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
BPC5-B	2.51	5.05	7.06	9.05	10.30	11.75	13.55	15.80	**D-39-3**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
BT1	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**D-42**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BT10	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**D-43**	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30
BT2	3.27	5.70	8.32	10.42	11.50	13.10	15.00	17.40	**D-44**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BT3	2.60	5.20	7.30	9.32	10.40	11.70	13.60	15.20	**D-45**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BT4	3.30	5.90	8.65	10.68	11.60	13.30	15.40	17.70	**D-48**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BT4-SA	3.17	5.60	8.07	10.17	11.50	13.10	15.50	17.80	**D-49**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BT5	3.24	5.95	8.24	10.33	10.90	12.65	14.90	17.00	**D-50**	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10
BT5-B	3.24	5.95	8.24	10.33	10.90	12.65	14.90	17.00	**D-51**	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90
BT6	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**D-53**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
BT6A	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**D-56**	3.40	6.20	8.82	10.75	11.00	12.50	14.80	17.00
BT7	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**D-60**	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10
BT8	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**D-61**	2.84	5.45	7.74	9.73	10.90	12.25	14.55	16.75
BT9	2.43	4.80	6.82	8.78	10.2	11.40	12.80	14.80	**D-61-B**	2.84	5.45	7.74	9.73	10.90	12.25	14.55	16.75

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C1	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**D-62-B**	2.57	5.00	7.22	9.32	10.90	12.40	14.00	15.70
C1-LF	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**D-64**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
CC1	2.49	5.00	6.98	8.93	10.10	11.50	13.10	14.90	**E1**	2.27	4.80	6.62	8.60	10.10	11.30	12.70	14.50
D-01	2.90	5.60	7.90	9.90	10.90	12.10	14.20	16.80	**E1-LF**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
D-06	2.51	5.10	7.06	9.05	10.30	11.70	13.30	15.40	**E1-LF-B**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
D10	2.51	5.10	7.06	9.08	10.50	12.10	13.80	15.90	**E2**	2.54	4.95	7.14	9.12	10.70	12.05	13.35	15.15
D-16N	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**E2-B**	2.49	4.95	6.98	9.02	10.60	12.05	13.35	15.15
D-16S	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**E2-LF**	2.51	5.00	7.06	9.07	10.40	11.65	12.85	14.60
D-1732	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**E2-LF-B**	2.51	5.00	7.06	9.07	10.40	11.65	12.85	14.60
D1A	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**FC**	2.75	5.20	7.49	9.52	11.10	12.80	14.90	17.10
D1B	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**GW10**	2.78	5.00	7.40	9.62	11.20	12.70	14.20	16.00
D1b-LF	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**GW11**	2.78	5.00	7.40	9.62	11.20	12.70	14.20	16.00
D1C	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**GW12**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
D1c-LF1	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**GW13**	2.16	4.70	6.30	8.13	9.30	10.40	12.00	14.00
D1c-LF2	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**GW14**	2.46	5.20	6.90	8.83	10.00	11.60	13.20	15.40
D1c-LF3	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**GW14-1**	2.46	5.20	6.90	8.83	10.00	11.60	13.20	15.40
D-25	2.78	5.30	7.57	9.62	11.20	12.80	14.80	16.90	**GW15**	2.27	4.90	6.62	8.53	9.70	11.00	12.60	14.50
D-25-B	3.17	5.30	7.95	9.88	11.30	12.80	14.80	16.90	**GW16**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20

Table 9-2085 without-project interior frequency curves (feet NAVD88 epoch 2004.65)

2085 MTG Without-Project Interior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
GW17	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30	**LL1**	2.75	5.20	7.49	9.42	10.50	11.70	13.40	15.00
GW18	2.57	5.00	7.22	9.32	10.90	12.55	14.10	15.85	**LL2**	2.60	5.20	7.30	9.32	10.40	11.70	13.50	15.10
GW18-B	2.57	5.00	7.22	9.32	10.90	12.55	14.10	15.85	**LL3**	2.81	5.30	7.66	9.60	10.60	11.80	13.80	15.60
GW2	2.60	5.20	7.30	9.32	10.40	11.70	13.60	15.20	**MC1**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
GW3	2.60	5.20	7.30	9.32	10.40	11.70	13.60	15.20	**OB1**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
GW4	2.75	5.30	7.49	9.43	10.60	11.90	14.00	15.90	**OB2**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
GW5	2.84	5.40	7.74	9.73	10.90	12.40	14.70	17.10	**OB3**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
GW6	2.87	5.40	7.82	9.85	11.10	12.60	14.80	17.40	**OB4**	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80
GW7	2.90	5.50	7.90	9.85	10.60	11.70	13.70	15.60	**PAC1**	3.20	5.70	8.16	10.20	11.20	12.50	14.80	17.30
GW8	2.27	4.70	6.62	8.65	10.40	11.80	13.70	15.50	**SL1**	2.57	5.20	7.22	9.25	10.50	12.00	14.00	15.80
GW9	2.78	5.20	7.57	9.55	10.80	12.00	13.90	16.20	**SL2**	2.84	5.40	7.74	9.73	10.90	12.30	14.40	16.30
HC1	2.19	4.70	6.38	8.23	9.40	10.50	12.00	13.90	**SL3**	3.24	5.70	8.24	10.30	11.30	12.70	15.00	17.10
HC2	2.22	4.70	6.46	8.32	9.40	10.40	12.00	13.90	**TS1**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HC3	2.30	4.90	6.70	8.63	9.80	11.10	12.60	14.40	**TS10**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HC4	2.27	4.90	6.62	8.53	9.70	10.90	12.30	14.20	**TS11**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC0	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30	**TS12**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC1	2.84	5.30	7.74	9.78	11.20	12.50	14.30	16.70	**TS13**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC10	2.27	4.94	6.62	8.57	9.90	11.45	13.25	15.55	**TS14**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50

HNC10-B	2.27	4.94	6.62	8.57	9.90	11.45	13.25	15.55	**TS15**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC2	2.90	5.40	7.90	10.00	11.50	12.90	14.80	17.40	**TS16**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC3	2.84	5.30	7.74	9.80	11.30	13.00	15.10	17.50	**TS17**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC4	2.81	5.30	7.66	9.72	11.30	13.00	14.90	17.40	**TS18**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC5	3.17	5.50	8.07	10.22	11.80	13.40	15.00	18.00	**TS19**	2.22	4.70	6.46	8.32	9.40	10.40	12.00	13.90
HNC6	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30	**TS2**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC7	3.14	5.40	7.99	10.08	11.50	13.00	14.60	17.30	**TS20**	2.22	4.70	6.46	8.32	9.40	10.40	12.00	13.90
HNC8	2.57	5.10	7.22	9.30	10.80	12.40	14.20	16.50	**TS21**	2.22	4.70	6.46	8.32	9.40	10.40	12.00	13.90
HNC9	2.30	4.90	6.70	8.65	9.90	11.60	13.30	15.55	**TS22**	2.22	4.70	6.46	8.32	9.40	10.40	12.00	13.90
HNC9-B	2.30	4.90	6.70	8.65	9.90	11.60	13.30	15.55	**TS3**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC9-E	2.27	4.90	6.62	8.58	10.00	11.60	13.20	15.40	**TS4**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
HNC9-W	2.46	5.00	6.90	8.88	10.30	11.90	13.60	15.80	**TS5**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
LB1	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**TS6**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
LB2	3.30	5.80	8.65	10.77	12.10	13.50	15.10	18.10	**TS7**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
LB3	3.24	5.70	8.24	10.35	11.60	13.20	14.90	17.70	**TS9**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
LB4	3.27	5.70	8.32	10.47	11.80	13.40	15.10	18.10	**US1**	2.43	4.80	6.82	8.80	10.30	11.60	12.60	14.50
LB5	2.75	5.30	7.49	9.45	10.70	12.20	13.80	16.10	**GW11-B**	2.78	5.00	7.40	9.62	11.20	12.70	14.20	16.00
LBB2	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**E1-B**	2.27	4.80	6.62	8.60	10.10	11.30	12.70	14.50
LBB3	2.43	4.80	6.82	8.78	10.20	11.40	12.80	14.80	**BB7-B**	2.14	4.64	6.22	8.10	9.60	10.85	11.80	13.20
LBB4	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**BD1-B**	2.78	5.00	7.40	9.63	11.30	12.60	14.30	16.20
LBB5	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**BC**	3.20	5.50	8.16	10.10	10.60	12.10	13.70	15.80
LBB6	2.14	4.64	6.22	8.10	9.60	10.40	10.90	11.90	**L2L-A**	2.51	5.00	7.06	9.12	10.70	11.80	13.60	15.80
LBC1	2.78	5.00	7.40	9.62	11.20	12.70	14.20	16.00	**L2L-B**	2.11	4.58	6.14	8.03	9.70	11.20	13.20	14.90
LBC2	3.20	5.60	8.16	10.25	11.50	13.00	15.50	18.00									
LF1	2.27	4.80	6.62	8.52	9.60	10.70	12.20	14.20									
LF2	2.27	4.80	6.62	8.52	9.60	10.70	12.20	14.20									
LF-GB	2.57	5.20	7.22	9.28	10.70	12.00	14.30	16.60									

Table 10-2085 without-project interior frequency curves (feet NAVD88 epoch 2004.65)

2035 MTG With-Project Exterior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
1-1AB	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**4-2**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
1-1AN	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**4-2A**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
11BE1	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**4-2B**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
11BE2	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**4-2C**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
11BE3	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**4-7**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
11BE4	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**4MGT**	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87
11BE5	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**5-1A**	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71
11BE6-E	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**5-1B**	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71
11BE6-W	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**6-1B1**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
1-1BU3-U1	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**6-1B1-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02

1-1BU3-U2	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**8-1N**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
1-1BU3-U3	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**8-1N-B**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
11BU4	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**8-1S-B**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
11BW11	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**8-2C**	1.57	3.06	4.93	7.60	8.43	10.29	12.50	14.82
11BW2-W1	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**8-2D**	1.57	3.06	4.93	7.60	8.43	10.29	12.50	14.82
11BW2-W2	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1AE**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW4-W3	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1AMID**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW4-W4	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1AW**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW4-W4A	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1BE**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW5	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1BMIDE**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW6	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1BMIDW**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW79	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**9-1BW**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
11BW79-W7	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**A1**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
1-2MID	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**B1**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
1-2N	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB1**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-2S	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB2**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-3	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB3**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-5	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**BB4**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-7_N3-4	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB5**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-7_N4-7	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB6**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
1-7_N7-10	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB7**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
1-7-N10-13	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BB8-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
1-7N13-16	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BD1**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-7N16-17	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BDL0**	1.57	3.06	4.93	7.60	8.43	10.29	12.50	14.82
1-7N17-24	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BDL1**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-7N24-28	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BDL2**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
1-8	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BDL3**	1.57	3.06	4.93	7.60	8.43	10.29	12.50	14.82
2-1A2	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BDL4**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
2-1B2-MID	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BDL4-B**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
2-1B2N	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BDL5**	1.57	3.06	4.93	7.60	8.43	10.29	12.50	14.82
2-1B2S	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BGC0**	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09
3-1B	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BGC1**	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09
3-1C	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**BGC2**	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09
4-1N	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**BGC3**	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09
4-1S	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**BGC4**	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09

Table 11-2035 with-project exterior frequency curves (feet NAVD88 epoch 2004.65)

2035 MTG With-Project Exterior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
BL1	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-26**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

BL2	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-28**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BL3	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-29**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BL4	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-30**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BL5	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-31**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BL6	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-34N**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BL7	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-34S**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BL89	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**D-35**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BPC1	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**D-36**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
BPC2	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**D-37**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
BPC3	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**D-38**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BPC4	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**D-39-1**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BPC5	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**D-39-2**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BPC5-B	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**D-39-3**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BT1	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49	**D-42**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT10	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-43**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
BT2	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49	**D-44**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT3	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49	**D-45**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT4	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49	**D-48**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT4-SA	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**D-49**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT5	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49	**D-50**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT5-B	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49	**D-51**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
BT6	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-53**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
BT6A	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-56**	1.99	5.15	9.09	11.91	12.69	14.32	17.03	19.49
BT7	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-60**	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71
BT8	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-61**	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87
BT9	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-61-B**	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87
C1	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-62-B**	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87
C1-LF	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**D-64**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
CC1	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**E1**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D-01	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**E1-LF**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D-06	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**E1-LF-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D10	1.83	4.36	7.52	10.23	11.10	13.00	15.56	18.79	**E2**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D-16N	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**E2-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D-16S	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**E2-LF**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D-1732	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**E2-LF-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
D1A	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**FC**	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83
D1B	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**GW10**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
D1b-LF	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**GW11**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
D1C	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**GW12**	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09

D1c-LF1	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**GW13**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
D1c-LF2	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**GW14**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
D1c-LF3	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02	**GW14-1**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
D-25	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**GW15**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
D-25-B	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**GW16**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56

Table 12-2035 with-project exterior frequency curves (feet NAVD88 epoch 2004.65)

2035 MTG With-Project Exterior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
GW17	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83	**LL1**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
GW18	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**LL2**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
GW18-B	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**LL3**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
GW2	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**MC1**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
GW3	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**OB1**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
GW4	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**OB2**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
GW5	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**OB3**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
GW6	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**OB4**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
GW7	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**PAC1**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
GW8	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**SL1**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
GW9	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**SL2**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
HC1	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**SL3**	1.96	5.02	8.83	12.00	12.88	14.64	17.04	19.88
HC2	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**TS1**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HC3	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**TS10**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HC4	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41	**TS11**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC0	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83	**TS12**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC1	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83	**TS13**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC10	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**TS14**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC10-B	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**TS15**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC2	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83	**TS16**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC3	1.80	4.19	7.18	9.95	10.88	12.55	14.82	17.83	**TS17**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC4	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**TS18**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC5	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**TS19**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC6	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**TS2**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC7	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**TS20**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC8	1.77	4.03	6.87	9.54	10.43	12.12	14.20	17.09	**TS21**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41

HNC9	1.83	4.36	7.52	10.23	11.10	13.00	15.56	18.79	**TS22**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
HNC9-B	1.83	4.36	7.52	10.23	11.10	13.00	15.56	18.79	**TS3**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC9-E	1.83	4.36	7.52	10.23	11.10	13.00	15.56	18.79	**TS4**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
HNC9-W	1.83	4.36	7.52	10.23	11.10	13.00	15.56	18.79	**TS5**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
LB1	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**TS6**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
LB2	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**TS7**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
LB3	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**TS9**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
LB4	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**US1**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
LB5	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71	**GW11-B**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56
LBB2	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**E1-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
LBB3	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BB7-B**	1.49	2.67	4.14	6.67	6.80	8.22	9.99	12.02
LBB4	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BD1-B**	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.60
LBB5	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**BC**	1.88	4.62	8.04	10.70	11.58	13.25	15.95	18.71
LBB6	1.50	2.70	4.21	5.93	6.93	8.49	10.47	12.56	**L2L-A**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
LBC1	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87	**L2L-B**	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41
LBC2	1.99	5.13	9.06	12.05	12.82	14.49	17.33	19.87									
LF1	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41									
LF2	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41									
LF-GB	2.01	5.25	9.29	12.68	13.81	15.56	17.82	20.41									

Table 13-2035 with-project exterior frequency curves (feet NAVD88 epoch 2004.65)

2085 MTG With-Project Exterior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
1-1AB	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**4-2**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
1-1AN	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**4-2A**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
11BE1	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**4-2B**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
11BE2	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**4-2C**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
11BE3	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**4-7**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17
11BE4	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**4MGT**	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50
11BE5	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**5-1A**	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82
11BE6-E	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**5-1B**	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82
11BE6-W	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**6-1B1**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-1BU3-U1	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**6-1B1-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-1BU3-U2	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**8-1N**	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21
1-1BU3-U3	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**8-1N-B**	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

11BU4	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**8-1S-B**	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21
11BW11	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**8-2C**	1.94	4.89	8.59	11.39	12.25	13.85	16.19	18.31
11BW2-W1	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**8-2D**	1.94	4.89	8.59	11.39	12.25	13.85	16.19	18.31
11BW2-W2	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1AE**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW4-W3	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1AMID**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW4-W4	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1AW**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW4-W4A	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1BE**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW5	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1BMIDE**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW6	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1BMIDW**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW79	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**9-1BW**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
11BW79-W7	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**A1**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-2MID	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**B1**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-2N	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB1**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-2S	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB2**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-3	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB3**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-5	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**BB4**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-7_N3-4	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB5**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-7_N4-7	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB6**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-7_N7-10	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB7**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-7-N10-13	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BB8-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
1-7N13-16	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BD1**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-7N16-17	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BDL0**	1.94	4.89	8.59	11.39	12.25	13.85	16.19	18.31
1-7N17-24	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BDL1**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-7N24-28	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BDL2**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
1-8	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BDL3**	1.94	4.89	8.59	11.39	12.25	13.85	16.19	18.31
2-1A2	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BDL4**	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21
2-1B2-MID	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BDL4-B**	2.75	5.25	8.66	11.42	12.42	14.41	16.77	19.21
2-1B2N	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BDL5**	1.94	4.89	8.59	11.39	12.25	13.85	16.19	18.31
2-1B2S	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BGC0**	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39
3-1B	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BGC1**	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39
3-1C	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**BGC2**	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39
4-1N	2.15	5.93	10.6	13.4	14.3	16.29	19.56	22.50	**BGC3**	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39

			7	2	7												
4-1S	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50	**BGC4**	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39

Table 14- 2085 with-project exterior frequency curves (feet NAVD88 epoch 2004.65)

2085 MTG With-Project Exterior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
BL1	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-26**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BL2	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-28**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BL3	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-29**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BL4	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-30**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BL5	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-31**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BL6	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-34N**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BL7	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-34S**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BL89	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**D-35**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BPC1	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**D-36**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
BPC2	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**D-37**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
BPC3	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**D-38**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BPC4	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**D-39-1**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BPC5	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**D-39-2**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BPC5-B	2.51	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**D-39-3**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BT1	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04	**D-42**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT10	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-43**	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21
BT2	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04	**D-44**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT3	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04	**D-45**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT4	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04	**D-48**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT4-SA	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50	**D-49**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT5	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04	**D-50**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT5-B	3.24	5.98	10.76	13.49	14.37	16.23	19.40	22.04	**D-51**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
BT6	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-53**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
BT6A	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-56**	2.16	5.98	10.76	13.49	14.37	16.23	19.40	22.04
BT7	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-60**	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82
BT8	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-61**	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50
BT9	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-61-B**	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50

C1	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-62-B**	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50
C1-LF	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**D-64**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
CC1	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**E1**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D-01	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50	**E1-LF**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D-06	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**E1-LF-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D10	1.97	5.07	8.94	11.62	12.59	14.56	16.85	19.91	**E2**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D-16N	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**E2-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D-16S	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**E2-LF**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D-1732	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**E2-LF-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
D1A	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**FC**	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21
D1B	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**GW10**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
D1b-LF	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**GW11**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
D1C	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**GW12**	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39
D1c-LF1	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**GW13**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17
D1c-LF2	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**GW14**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17
D1c-LF3	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54	**GW14-1**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
D-25	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50	**GW15**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
D-25-B	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50	**GW16**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27

Table 15-2085 with-project exterior frequency curves (feet NAVD88 epoch 2004.65)

2085 MTG With-Project Exterior Frequency Curves																	
Economic Reach	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**	**Economic Reach**	**0.999**	**0.2**	**0.1**	**0.04**	**0.02**	**0.01**	**0.005**	**0.002**
GW17	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21	**LL1**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
GW18	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**LL2**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
GW18-B	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**LL3**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
GW2	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**MC1**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
GW3	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**OB1**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
GW4	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**OB2**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
GW5	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**OB3**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
GW6	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**OB4**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
GW7	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**PAC1**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17
GW8	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**SL1**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17
GW9	2.29	6.64	12.07	15.2	16.3	18.23	21.15	24.49	**SL2**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

				4	7												
HC1	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**SL3**	2.24	6.39	11.57	14.70	15.67	17.42	20.64	24.17
HC2	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**TS1**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HC3	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**TS10**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HC4	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49	**TS11**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC0	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21	**TS12**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC1	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21	**TS13**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC10	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**TS14**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC10-B	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**TS15**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC2	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21	**TS16**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC3	1.95	4.93	8.66	11.42	12.42	14.41	16.77	19.21	**TS17**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC4	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**TS18**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC5	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**TS19**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC6	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**TS2**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC7	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**TS20**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC8	1.92	4.79	8.39	10.94	11.97	13.86	16.01	18.39	**TS21**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
HNC9	1.97	5.07	8.94	11.62	12.59	14.56	16.85	19.91	**TS22**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
HNC9-B	1.97	5.07	8.94	11.62	12.59	14.56	16.85	19.91	**TS3**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC9-E	1.97	5.07	8.94	11.62	12.59	14.56	16.85	19.91	**TS4**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
HNC9-W	1.97	5.07	8.94	11.62	12.59	14.56	16.85	19.91	**TS5**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
LB1	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**TS6**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
LB2	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**TS7**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
LB3	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**TS9**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
LB4	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**US1**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
LB5	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82	**GW11-B**	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27
LBB2	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**E1-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
LBB3	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BB7-B**	1.90	4.68	8.16	11.71	12.30	13.90	15.45	17.54
LBB4	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BD1-B**	2.78	5.00	7.84	10.16	11.67	13.30	15.19	17.27
LBB5	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**BC**	2.05	5.46	9.72	12.47	13.47	15.23	18.12	20.82
LBB6	1.86	4.52	7.84	10.16	11.67	13.30	15.19	17.27	**L2L-A**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
LBC1	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50	**L2L-B**	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49
LBC2	2.15	5.93	10.67	13.42	14.37	16.29	19.56	22.50									

LF1	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49									
LF2	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49									
LF-GB	2.29	6.64	12.07	15.24	16.37	18.23	21.15	24.49									

Table 16-2085 with-project exterior frequency curves (feet NAVD88 epoch 2004.65)

2.4 Fragility Curves for Non-Federal and Federal Levees

The MTG project study project levees will be designed to reduce risk in the study area from storm surge and tidal influences from the Gulf of Mexico. Even though the project levees are designed and engineered to withstand the conditions chosen by the project members, a levee performance analysis is required for both non-federal (local levees) and federal levee. The levees will endure atypical conditions and must perform differently than other levees in a normal river system. This is primarily due to their continuous exposure to water on both sides of the levees. Additional issues associated with levees include tidal fluctuation, wave run-up; and poor foundation conditions due to organic soils. The study evaluated the integrity of the local levees and federal levee performance by implementation of fragility curves within the HEC-FDA model. Local levee systems provide flood risk reduction in the without-project conditions for base year 2035 and future year 2085. The fragility curves for the non-federal levees from the PACR were adopted for the study. The fragility curves from the PACR were based on structural failure of the local levees due to erodibility and stability; wave overtopping was not considered. Table 17 shows the non-Federal levee fragility curves and the top of levee elevations developed for each economic reach containing a local levee for without-project conditions. Local levees were also considered in the with-project condition if the economic reach will be located on the flood side after the federal levee was constructed. Economic reaches located outside of the proposed MTG alignment on the flood side are denoted with the suffix-B except for economic reach L2L-B.

MTG Non-Federal Levee Fragility Curves							
Economic Reach	**Top of Levee**	**Economic Reach**	**Top of Levee**	**Economic Reach**	**Top of Levee**	**Economic Reach**	**Top of Levee**
1-1AB	5	1-7N24-28	5.5	9-1AE	8	D-16S	4
1-1AN	5	3-1B	9.5	9-1AMID	8	D-25	7
11BE4	6	3-1C	6	9-1AW	8	D-25-B	7
11BE5	4	4-1N	4	9-1BE	8	D-29	6.5
11BE6-W	6	4-1S	7	9-1BMIDE	8	D-30	4
11BW11	3	4-2	4	9-1BMIDW	8	D-36	9.5
11BW5	5.5	4-2A	6	9-1BW	8	D-48	4
11BW6	5.5	4-2B	6	BL2	6	D-53	5
11BW79	6	4-2C	6	BL3	6	D-56	6
11BW79-W7	5.5	4-7	6	BL4	5	D-60	6
1-2S	4	4MGT	6	BL5	5	D-61	6
1-3	6.5	5-1A	6	BL6	5	D-61-B	6
1-5	3	5-1B	6	BL7	6	D-62-B	6
1-7_N3-4	5.5	6-1B1	6	BL89	5	D-64	5

1-7_N4-7	5.5	6-1B1-B	6	BPC3	6	E2-LF	5.4
1-7_N7-10	5.5	8-1N	4	BPC4	6	E2-LF-B	5.4
1-7-N10-13	5.5	8-1N-B	4	BT4	6	LBC1	6
1-7N13-16	5.5	8-1S-B	4	BT4-SA	7	LBC2	6
1-7N16-17	5.5	8-2C	6	D-01	10	PAC1	10
1-7N17-24	5.5	8-2D	6	D10	6	SL3	10

Table 17-Non-federal levee fragility curves (feet NAVD88 epoch 2004.65)

The proposed federal levee system will provide flood protection to the interior study area. The performance of the federal levee was also analyzed in the study by implementing fragility curves in HEC-FDA model. The fragility curves were used to analyze the risk of levee failure based on breaching due to overtopping along the system in the with-project condition for base year 2035 and future year 2085. The fragility curves were developed using the same criteria from the PACR but with revised surge and wave parameters from the updated coupled ADCIRC + SWAN model. Single point fragility curves were developed for each levee construction reach based on a stillwater elevation which would produce an overtopping rate of 2cfs/ft in agreement with the wave overtopping simulator results completed by Colorado State University. The research concluded grass covered levees would likely fail if armoring was not present once an overtopping rate of 2 cfs/ft or higher was achieved. The single point failure mode is the proxy for a typical fragility curve that meets the intent of ER 1105-2-101 to address risk and associated consequences. The stillwater elevation which initiates erosion is summarized by levee reach in Table 18. It is important to note the elevations are not the same as the levee design elevations listed in Tables 3 and 4.

MTG Federal Levee Fragility Curves		
Levee Reach	**Single Point Fragility Curves based on 2cfs/ft Overtopping Rate**	
	2035 with- project	**2085 with- project**
	HEC-FDA top of levee	**HEC-FDA top of levee**
A	12.13	16.16
B	13.83	16.90
E	16.00	18.50
F	15.47	16.97
G	16.77	17.97
H	17.12	19.62
I	18.32	21.83
J	18.53	21.29
K	18.22	22.59
L	18.54	21.76
Barrier	11.43	16.55

Table 18-Federal levee fragility curves (feet NAVD88 epoch 2004.65)

2.5 Interior- Exterior Relationships for Federal Levees

An interior-exterior stage relationship must be considered in the analysis in the HEC-FDA model to accurately model the existing levees in the study area. The interior-exterior stage relationship defines the relationship between the water surface, or stage, inside of the levee and the stage within the floodplain behind the levee. In the event of a levee failure as determined by the fragility curves, the interior water surface elevations would rise in the interior (on the protected side) to the same stillwater elevation of the exterior in the with-project conditions.

2.6 Updates to Design Parameters from the PACR

Table 19 lists revisions to design parameters, models, and assumptions from the PACR and changes due to implementation of the revisions. In the PACR report for the 1% levee design, elevations range from 14.0 to 24.0 for year 2035 and 19.5 to 26.5 for year 2085. The updated design elevations based on updated parameters range from 8.5 to 21.5 for year 2035 and 12.0 to 26.0 for year 2085. The updated levee elevations have decreased for the same level of protection since the adjusted overtopping rate was implemented in the levee design. Additionally, the stillwater elevations in the updated coupled ADCIRC + SWAN model are lower for the design return (100 year).

Design Parameter	Design Change	Notes
ADCIRC + SWAN model storm surge characteristics	New storm surge characteristics from the updated ADCIRC model were used to develop stage frequency curves, fragility curves, levee design elevations, and structure design elevations.	Stage frequency curves, fragility curves, levee designs and structure design elevations are lower than the elevations presented in the PACR. The stillwater elevations for the 1,2,5,10 year are higher than the PACR coupled ADCIRC + SWAN model. The stillwater elevations for the 25 year to 1000 year are lower than the PACR ADCIRC + SWAN model.
Overtopping equations	Van der Meer overtopping equations changed to EurOtop overtopping equations for use in computing levee design elevations.	Implementation of the EurOtop equation resulted in a change in levee height of approximately 0.50 feet lower than van der Meer. The ½ foot variation is within the uncertainty band of the model (+/-0.50 feet) and could vary based on the use of a different surge model result output point.
Overtopping threshold rate	Overtopping threshold rate increased from 0.1cfs/ft to 0.5cfs/ft	Overtopping threshold rate of 0.5cfs/ft approved from the post PACR RMC site adaptation report was used for levee designs and corresponding structure design elevations which resulted in lower design elevations.
Removal of wave berm design option	A berm factor was not incorporated in the levee design equations.	In the PACR levee elevations for a few construction reaches were determined with-and without-wave berms. In this analysis wave berms were not used which would result in higher elevations than levees designed with-wave berms.

Table 19-Design Changes

2.7 Conclusions

All information presented above is based on available data and applicable guidance at the time of the study. **For this reason, all stage and wave frequency data should be reviewed and possibly recomputed during the Preconstruction Engineering and Design (PED) phase of the project.**

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Appendix E

EDS (Structures) Input

APPENDIX E
MORGANZA TO THE GULF
EDS INPUT TO THE 2021 MII COST CERTIFICATION

TABLE OF CONTENTS

1.0 Introduction and General

Appendix E summarizes the work that was performed to develop sufficient quantities for the structural features that are part of the Morganza to the Gulf Hurricane Risk Reduction Alignment (M2G). Feasibility level designs for structural components were last developed during the 2013 PACR for the 1% AEP. New quantities for structural components were developed based on:

1. New (lower) hydraulic design grades (Reference Appendix D)
2. Input from the NFS regarding structures that have been locally built
3. Application of "adapted criteria" which is explained in the main text of the report.

In general, quantities were pro-rated in consideration of these factors based on the 2013 PACR feasibility level designs. For the 56' barge gate structures, previously assumed to be sector gates in the PACR, a limited design approach was followed, utilizing existing designs from the Non-Federal Sponsor constructed within the last 10 years.

The design elevations used for each structure are the same as the design elevation developed by EDHH for each levee reach. The table below summarizes the design elevations used for each structure.

Structure	Design EL (ft)
Bayou Black 56' BG	17.00
Shell Canal East 56' BG	17.00
Minors Canal 56' BG	16.50
Falgout Canal 56' BG	18.50
Bayou du Large 56' BG	21.00
Bayou Grand Caillou 56' BG	18.50
Bayou Petite Caillou 56' BG	20.00
Placid Canal 56' BG	22.00
Bush Canal 56' BG	24.00
Bayou Terrebonne 56' BG	25.00
Humble Canal 56' BG	24.50
Pointe Aux Chenes 56' BG	23.50
Grand Bayou 56' BG	24.50
GIWW West 125' BG	16.50
GIWW East 125' BG	15.50
Elliot Jones 20' Stoplog Gate	17.00
Humphreys Canal 20' Stoplog Gate	17.00
Shell Canal West 30' Stoplog Gate	17.00
Marmande Canal 30' Stoplog Gate	18.50
Four Point Bayou 30' Stoplog Gate	19.50
Barrier 1 ECS	17.00

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Structure	Design EL (ft)
Barrier 2 ECS	17.00
Barrier 3 ECS	17.00
Barrier 4 ECS	17.00
Barrier 5 ECS	17.00
Barrier 6 ECS	17.00
Barrier 7 ECS	17.00
Reach A ECS	16.50
Reach E-1 ECS	20.00
Reach E-2 ECS	21.00
Reach G-2 – 1 ECS	20.50
Reach G-2 – 2 ECS	20.50
Reach G-2 – 3 ECS	20.50
Reach H-1 – 1 ECS	20.00
Reach H-1 – 2 ECS	20.00
Reach J2 – 1 ECS	25.00
Reach J2 – 2 ECS	25.00
Reach J2 – 3 ECS	25.00
Reach K – 1 ECS	26.00
Reach K – 2 ECS	26.00
Reach L ECS	24.50
Madison PS Fronting Protection	25.00
Pointe Aux Chenes PS Fronting Protection	23.50
Bayou Black PS Fronting Protection	17.00
Hanson Canal PS Fronting Protection	17.00
Hwy 315 Swing Gate	21.00
Hwy 55 Swing Gate	25.00
Hwy 56 Swing Gate	20.00
Hwy 665 Swing Gate	23.50
Four Point Road Swing Gate	19.50
NAFTA Swing Gate	17.00
C North Gulf South Pipeline	16.50
C North American Midstream Pipeline	16.50
C North Williams Discovery Pipeline	16.50
ECS Lockport to Larose 1	13.00
ECS Lockport to Larose 2	13.00
Union Pacific Railroad 36’ Swing Gate	13.00
Larose FG 56’ SG	16.50
GIWW Floodwall and Hwy 24 and Hwy 3235 36’ Swing Gates	16.50

1.1 Electrical & Mechanical Designs

No electrical or mechanical designs were developed under the current effort (i.e. 2021 Economic Analysis) for any of the structural components in the levee alignment. Historical bid data from the NFS was used to develop a cost estimate. The same operating machinery used in the 3% AEP PACR was used for the new 2085 1% AEP.

1.2 General statements regarding EDS Approach

This Appendix describes the structural design approach that was utilized during development of the 2013 PACR feasibility level designs and how prorations were applied where applicable. Generally, unless stated otherwise, designs with pro-rated quantities have been developed based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation.

ER 1110-2-8152 will be followed throughout the project design process, requiring that all cofferdams will be designed by the Government.

2.0 Houma Navigation Canal Lock

Houma Navigation Lock was not designed as part of this study. The cost was based on actual bid costs for the NFS designed Lock complex.

3.0 56-foot Barge Gates

The barge gates will consist of various structural shapes and plates in a hollow box configuration. All connections will be welded connections. Gate quantities were estimated using examples of Non-Federal Sponsor barge gates that are currently in use. Steel tonnage was estimated by overall gate geometry with current levels of risk reduction and depth of gate submergence. The estimates were then prorated for future required levels of risk reduction.

Guidewalls and pile clusters will be provided as aids to navigation and to protect the main flood gate structure from impact. Details were taken from historical 56-foot sector gate structures constructed in the New Orleans District rather than performing actual design on these components

The table below provides a list of 56-foot Barge gates in the alignment.

Structure	Sill Elevation	Design EL (ft)	Top of Guidewalls
Bayou Black	-12.0	17.0	10
Shell Canal East	-12.0	17.0	10
Minors Canal	-9.0	16.5	10
Falgout Canal	-9.0	18.5	10
Bayou du Large	-7.0	21.0	10
Bayou Grand Caillou	-12.0	18.5	10
Bayou Petite Caillou	-8.0	20.0	10
Placid Canal	-8.0	22.0	10
Bush Canal	-12.0	24.0	10
Bayou Terrebonne	-9.0	25.0	10
Humble Canal	-9.0	24.5	10
Pointe Aux Chenes	-6.0	23.5	10
Grand Bayou	-9.0	24.5	10
Larose	-12.3	16.5	10

3.1 Physical Features

The physical features associated with the construction of the 56-foot barge gate structures are:

- Temporary Bypass Channels
- Phase 1 and 2 Interior Braced Cofferdams
- Barge Gate Concrete Landing Slab
- Landing Slab Pile Foundation
- Receiving Structure Concrete Monoliths
- Receiving Structure Pile Foundations
- Pivot Arm Assembly
- Steel Barge Gate
- Needle Girder, Needles and Supports
- Needle Girder Storage Platform
- Guidewalls and Pile Clusters
- Sluice Gate Concrete Monolith*
- Sluice Gate Pile Foundation*
- Sluice Gates*
- Sluice Gate Bulkheads*
- Tie-in T-Walls
- Electrical Controls and Circuitry

- Mechanical Equipment

*(Bayou Grand Caillou, Bush Canal, Falgout Canal, Grand Bayou, Placid Canal, and Bayou Petite Caillou only)

3.2 Construction Sequencing

All barge gates will be constructed approximately in the center of the existing channels. A minimum 60-foot temporary bypass channel will be constructed as the first order of construction, allowing navigation passage during construction. Once navigation is routed through the temporary bypass channel, a cofferdam will be constructed, permitting the construction of the 56-foot barge gate landing slab, receiving structure monoliths, and the sluice gate monoliths, if applicable. Reduced power will be required for vessels passing through the construction area to reduce the risk of impact to the cofferdam. A timber guidewall and pile clusters will be provided along the bypass channel to prevent vessel impact on the cofferdam. Once construction of the 56-foot barge gate landing slab, pivot arm assembly, receiving structure monoliths, and sluice gate monoliths is completed, navigation will be re-routed through the permanent barge gate structure. A phase 2 cofferdam will be required for the T-Walls adjacent to the barge gate/sluice gate structures. Once navigation is re-routed, the phase 2 cofferdam, permanent guidewalls and pile clusters, tie-in T-walls and final civil site work can be completed.

3.3 Cofferdams

A Phase 1 cofferdam will be constructed to permit the in-the-dry construction of the barge gate concrete landing slab, pivot arm assembly, receiving structure concrete monoliths, and the sluice gate concrete monolith (if applicable). The cofferdam is an internally braced cofferdam with wide-flange walers and pipe braces supporting PZ sheet piling. Anchor forces, bending moment in the sheet piling, and required sheet piling tip elevations were computed for Bush Canal, Bayou du Large, and Point Aux Chenes. Bayou du Large cofferdam design was conservatively used for all remaining structures where no design was performed.

A Phase 2 cofferdam will be constructed to permit the construction of the adjacent T-Walls to the barge gate/sluice gate structures that will be in the water. The same anchor forces, moments, and tips used for the Phase 1 cofferdams will be conservatively used for the Phase 2 cofferdams.

3.4 Receiving Structure Monolith Concrete

Receiving Structure walls were designed as cantilever beams extending from the base slab. A constant wall thickness was assumed for the full height of the walls. Typical walls were designed for gates with water protection elevations of 17 feet and 25 feet. No pro-rating of wall thickness was performed. The resulting calculated wall thicknesses are summarized in the table below.

Structure	Wall Thickness (ft) (2085 1% AEP)
Bayou Black	4.50
Shell Canal East	4.50
Minors Canal	4.50
Falgout Canal	4.50
Bayou du Large	7.50
Bayou Grand Caillou	4.50
Bayou Petite Caillou	7.50
Placid Canal	4.50
Bush Canal	7.50
Bayou Terrebonne	7.50
Humble Canal	7.50
Pointe Aux Chenes	4.50
Grand Bayou	7.50
Larose	4.50

3.5 Receiving Structure Slabs

The Receiving Structure base slabs for 17-foot protection level were estimated to be 45 feet long by 36 feet wide. The Receiving Structure base slabs for 25-foot protection level were estimated to be 72 feet long by 48 feet wide. The base slab thicknesses were determined by matching the wall thicknesses (for ease of moment transfer) and adding depth for pile embedment. The base slab thicknesses are summarized in the table below.

Structure	Slab Thickness (ft) (2085 1% AEP)
Bayou Black	6.50
Shell Canal East	6.50
Minors Canal	6.00
Falgout Canal	6.00
Bayou du Large	6.50
Bayou Grand Caillou	6.50
Bayou Petite Caillou	9.50
Placid Canal	6.50
Bush Canal	9.50
Bayou Terrebonne	9.50
Humble Canal	9.50

Structure	Slab Thickness (ft) (2085 1% AEP)
Pointe Aux Chenes	6.50
Grand Bayou	9.50
Larose	6.50

3.6 Landing Slab

The 56-foot barge gate landing slab was estimated to be 72 feet long by 36 feet wide by 4 feet deep.

3.7 Receiving Structure Pile Foundations

The pile foundation for Receiving Structures will include 20, 36-inch pipe piles for 17-foot protection level and 24, 48-inch pipe piles for 25-foot protection level. The design Factors of Safety utilized for the design comply with EM 1110-2-2906 and the latest requirements in the HSDRRS Design Guidelines. Pile capacities were based on data curves for Bush Canal Flood Gate. Tension hooks would be provided on all piles experiencing tension loads. CPGA analysis was performed. No pro-rating was performed. Alternative pile types and arrangements will be investigated during detailed design for each structure to optimize the pile foundation. The pile foundation for Landing Slabs will include 32, 36-inch pipe piles.

3.8 CPGA Analysis

CPGA was utilized to develop the pile layouts for the receiving structures and determine the required tip elevation. The piles were modeled as pinned connections with the piles providing all of the lateral resistance. The horizontal subgrade modulus was based on the soil within the top ten pile diameters from grade. The horizontal subgrade modulus was reduced for group effects in accordance with EM 1110-2-2906.

3.9 Pile Curves and Horizontal Subgrade Modulus

Pile curves and horizontal subgrade modulus were taken from “36-in Diameter Steel Pipe Piles” data curves for Bush Canal Flood Gate provided by Geotechnical Branch. The resulting pile tip estimates are summarized in the table below:

Structure	Pile Tip (ft) (1% AEP)
Bayou Black	-145.0
Shell Canal East	-145.0
Minors Canal	-145.0

Structure	Pile Tip (ft) (1% AEP)
Falgout Canal	-145.0
Bayou du Large	-145.0
Bayou Grand Caillou	-145.0
Bayou Petite Caillou	-155.0
Placid Canal	-145.0
Bush Canal	-155.0
Bayou Terrebonne	-155.0
Humble Canal	-155.0
Pointe Aux Chenes	-145.0
Grand Bayou	-155.0
Larose	-145.0

3.10 Cut-off Wall

A cut-off sheetpile wall will be provided to reduce possible seepage, scouring and uplift. A PZC-13 sheetpile meeting the requirements of ASTM A572, Grade 50 was assumed for the cutoff wall. Tip elevations were provided by New Orleans District Engineering Division Geotechnical Branch utilizing Lane's Weighted Creep Ratio for each structure.

3.11 Sluice Gates & Walls

The sluice gates will be manufactured 16'0" by 16'0" or 16'0" by 12'0" cast iron gates. The sluice gate wall quantities were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the December 2020, 2085 1% design elevations provided by EDHH.

3.12 Sluice Gate Base Slab

The sluice gate base slab thickness from the 3% AEP PACR was used for the new 2085 1% AEP elevation and are summarized below:

Structure	Slab Thickness (ft) (2085 1% AEP)
Bayou Grand Caillou	5
Bayou Petite Caillou	7
Placid Canal	7
Bush Canal	7
Falgout Canal	5
Grand Bayou	7

3.13 Sluice Gate Pile Foundation

The pile foundation for the sluice gates will include HP14x73 piles battered on 3V/1H. Pile capacities were based on the use of compression pile testing, but no tension pile testing. Tension hooks will be provided on all piles on the flood side of the sheet pile cut-off wall to handle the maximum tensile load. The tip elevations were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. Alternative pile types and arrangements will be investigated during PED design phases for each structure to optimize the pile foundation.

3.14 Cut-off Wall

A cut-off sheetpile wall will be provided to reduce possible seepage, scouring and uplift. A PZC-13 sheetpile meeting the requirements of ASTM A572, Grade 50 was assumed for the cut-off wall. Tip elevations from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

3.15 Bulkheads

The sluice gate bulkheads are designed to dewater the entire gatebay permitting maintenance of the sluice gates and concrete gatebay. The bulkheads were designed for a sill elevation of -12.0 with a water elevation of +5.0. Each sluice gate structure will be provided with four bulkheads, permitting the dewatering of two sluice gate bays at a time.

The steel bulkheads consist of horizontal L8x4x1/2 members with a 3/8-inch skin plate. The bulkhead design from the 3% AEP PACR structures was used for the new 20185 1% AEP elevation as the dewatering loads are the same. All steel will be constructed from material conforming to ASTM A572, Grade 50.

3.16 Tie-in T-Walls

Tie-in T-Walls extend from the sector gate/sluice gate structures to the adjacent full-levee section. The distance from the gate structure to the full-levee section was calculated for the 3% AEP PACR. The monolith numbers and lengths determined from the PACR were used for the new 2085 1% AEP. A 30-foot sheetpile cut-off will be embedded into the levee at the transition between the tie-in T-Walls and the levee section. Nine inches of reinforced concrete scour protection will be provided at the transition area. A 2-foot soil pre-load will be provided above the final grade along the T-Walls to eliminate settlement induced bending effects.

Typical designs were created during the development of the 3% AEP PACR and were categorized according to hydraulic reach and base elevation. For the 2085 1% AEP, the T-wall sections were re-categorized based on the new elevations and the designs developed from the 3% AEP PACR were used. The required pile tip was determined individually for each structure based on the pile capacity demand from the typical designs. Pile capacities were based on the use of compression pile testing, but no tension pile testing. Tension hooks are provided on all piles on the flood side of the sheet pile cutoff- wall to handle the maximum tensile load.

4.0 125-foot Sector Gate

The sector gates will consist of structural pipe sections supporting the vertical intercostals and skin plate with a central angle of 70. All connections will be welded connections. A rack and pinion gear system will operate the gate. All steel members on the gate will be painted with a coal tar epoxy paint system. The sector gate steel quantities were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. The table below lists the structures examined:

Structure	Sill Elevation	Design El (ft)	Top of Guidewalls
GIWW West	-16	28	10
GIWW East	-16	18	10

4.1 Physical Features

The physical features associated with the construction of the 125-foot sector gate structures are:

- Temporary Bypass Channels
- Phase 1 Cellular Cofferdam
- Phase 2 Interior Braced Cofferdams
- Sector Gate Concrete Monolith
- Sector Gate Pile Foundation
- Steel Sector Gate
- Needle Girder, Needles and Supports
- Needle Girder Storage Platform
- Guidewalls
- End Cell Dolphins
- Sluice Gate Concrete Monolith
- Sluice Gate Pile Foundation

- Sluice Gates
- Sluice Gate Bulkheads
- Tie-in T-Walls
- Electrical Controls and Circuitry
- Mechanical Equipment

4.2 Construction Sequencing

Both 125-foot sector gates will be constructed in the approximate center of the existing channels. A minimum 125-foot temporary bypass channel will be constructed as the first order of construction, to allow navigation passage during construction. Once navigation is routed through the temporary bypass channel, a cellular cofferdam will be constructed, permitting the construction of the 125-foot sector gate monolith and the sluice gate monoliths. Reduced power will be required for vessels passing through the construction area to reduce the risk of impact to the cofferdam. A timber guidewall and pile clusters will be provided along the bypass channel to minimize potential vessel impact on the cofferdam. Once construction of the 125-foot sector gate monolith and sluice gate monoliths is completed, navigation will be re-routed through the permanent sector gate structure. A phase 2 cofferdam will be required for the T-Walls adjacent to the sector gate/sluice gate structures. Once navigation is re-routed, the phase 2 cofferdam, needle girder storage platform, permanent guidewalls, end cell dolphins, tie-in T-Walls and final civil site work can be completed.

4.3 Phase 1 Cellular Cofferdam

A Phase 1 cellular cofferdam will be constructed to permit the in the dry construction of the sector gate concrete monolith and the sluice gate concrete monolith. The cofferdam will be a sheet pile cellular cofferdam filled with sand. Deep soil mixing will be necessary in the interior of the cellular structure to provide adequate geotechnical safety factors. The same cofferdam designed for the PACR structures was used for this cost certification.

4.4 Phase 2 Interior Braced Cofferdams

A phase 2 cofferdam will be constructed to permit the construction of the adjacent T-Walls to the sector gate/sluice gate structures that will be in the water. The anchor forces, moments, and tips used for the Phase 1 Bayou du Large sector gate phase 1 cofferdams developed for the PACR was conservatively used for the Phase 2 cofferdams.

4.5 Sector Gate Monolith Concrete, Wall, and Thrust/Machinery Block

Quantities for these features were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation.

4.6 Sector Gate Base Slab

The 125-foot sector gate base slab will measure 310'6" long by 117'8" wide. The sector gate base slab thickness from the 3% AEP PACR was used for the new 2085 1% AEP elevation and is summarized in the table below:
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Structure	Slab Thickness (ft) (2085 1% AEP)
GIWW West	10
GIWW East	10

4.7 Sector Gate Pile Foundation

The pile foundation for the sector gates will include 246 24-inch pipe piles with 1/2-inch thick wall thickness battered on 4 vertical to 1 horizontal slope. Pile capacities were based on the use of compression pile testing, but no tension pile testing. Tension hooks are provided on all piles. The tip elevations were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. Alternative pile types and arrangements will be investigated during detailed PED design for each structure to optimize the pile foundation.

4.8 Cut-off Wall

A cut-off sheetpile wall will be provided to reduce possible seepage, scouring and uplift. A PZC-13 sheetpile meeting the requirements of ASTM A572, Grade 50 was assumed for the cut-off wall. Tip elevations from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

4.9 Needle Girders, Needles and Supports

The needle girder system arrangement was designed to dewater the entire gatebay permitting maintenance of the sector gates. The needle girder system was designed for a sill elevation of -16.0 with a water elevation of +5.0. Each gate structure will be provided with 24 steel needles (12 on each side of the structure), measuring 14'6" in width, used to dewater the concrete gatebay monoliths. The steel needles will consist of vertical WT8x38.5 members with a 7/16-inch skin plate. The needles will be supported by the sill of the concrete gatebay and the needle girder at El +5.0. The needle girder was designed as a simply supported, built-up girder, spanning across the 125-foot gate opening. The girder will be supported along its weak axis by three support towers. The girder at mid-span has a depth of 8’4” with a 3/4-inch web and 2 inch by 20 inch flanges. The girder will taper down to a depth of 5’4” at the ends. The support towers will consist of welded HSS connections, supporting the dead and vertical live loads of the needle girder.

4.10 Needle Girder Storage Platform

The needle girder storage platform will be a reinforced concrete structure measuring 71 feet wide by 135 feet long. The structure will consist of an 8-inch cast-in-place slab supported by 40-inch wide by 30-inch deep cast-in-place beams, spaced 9 feet on center. The storage platform will be supported by 60 24-inch square, 80-foot long, precast, pre-stressed concrete (PPC) piles.

4.11 Guidewalls

Guidewalls will be provided as aids to navigation and to protect the main flood gate structure from impact. Details were taken from the HNC Lock structure as both structures will see similar vessel traffic.

4.12 End Cell Dolphins

End Cell Dolphins will protect the main flood gate structure and guidewalls from head-on impact from errant vessels. The end cell design was taken from the Western Closure Complex 225-foot Sector Gate, where similar vessel traffic is seen along the GIWW. The end cell will consist of a 60-foot sheet pile cellular structure with a concrete ring in the interior of the cell. The inside of the concrete ring will be filled with lightweight material. The concrete structure will be supported by 18-inch diameter pipe piles.

4.13 Control Houses

A precast 14-foot square concrete control house will be provided for each gate leaf to shelter the gate control systems and machinery and provide space for a gate operator as required. The buildings are considered small and were not designed; so, historical dimensions were used for cost estimation purposes. It is assumed that these buildings will be pre-fabricated products.

4.14 Sector Gate Sluice Gates

The sluice gates will be manufactured 16’ by 16’ or 16’ by 12’ iron gates.

5.0 Stop-Log Gates

This section contains a summary of work for the three 30-foot stop log gate structures and the two 20-foot stop log gate structures. The table below lists the structures examined:

Structure	Sill Elevation	Design El (ft)	Top of Guidewalls
Elliot Jones	-8.0	17.0	10.0
Humphreys Canal	-8.0	17.0	10.0
Shell Canal West	-8.0	17.0	10.0
Marmande Canal	-8.0	18.5	10.0
Four Point Bayou	-8.0	19.5	10.0

5.1 Physical Features

The physical features associated with the construction of the stop log gate structures are:

- Interior Braced Cofferdams
- Stop Log Gate Concrete Monolith
- Stop Log Gate Pile Foundation
- Stop Log Gate
- Crane Platform T-Wall
- Needle Girder and Needles
- Bulkhead Storage Platform
- Guidewalls & Pile Clusters
- Tie-in T-Walls
- Mechanical Equipment

5.2 Construction Sequencing

All stop log gates will be constructed approximately in the center of the existing channels. A minimum 20-foot or 30-foot (depending on gate opening size) temporary bypass channel will be constructed as the first order of construction, allowing navigation passage during construction. Once navigation is routed through the temporary bypass channel, a cofferdam will be constructed, permitting the construction of the stop log gate monolith and the crane platform T-Wall monolith. Reduced power will be required for vessels passing through the construction area to reduce the risk of impact to the cofferdam. A timber guidewall and pile clusters will be provided along the bypass channel to prevent vessel impact on the cofferdam. Once construction of the stop log gate monolith and the crane platform T-Wall monolith is completed, navigation will be re-routed through the permanent stop log gate structure. A phase 2 cofferdam will be required for the T-Wall adjacent to the stop log gate structures. Once navigation is re-routed, the phase 2 cofferdam, bulkhead storage platform, permanent guidewalls and pile clusters, tie-in T-Walls and final civil site work can be completed.

5.3 Cofferdams

A Phase 1 cofferdam will be constructed to permit the in the dry construction of the stop log concrete monolith and the crane platform T-Wall monolith. The cofferdam is an internally braced cofferdam with wide flange walers and pipe braces supporting PZ sheet piling. Anchor forces, bending moment in the sheet piling, and required sheet piling tip elevation calculated for Bayou du Large sector gate during the development of the PACR were conservatively used for the stop log gate structures.

A phase 2 cofferdam will be constructed to permit the construction of the adjacent T-Walls to the stop log gate that will be in the water. The same anchor forces, moments, and tips used for the Phase 1 cofferdams were conservatively used for the Phase 2 cofferdams.

5.4 Walls & Base Slab

The stop log wall quantities were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. The stop log base slab thickness from the 3% AEP PACR was used for the new 2085 1% AEP elevation and is summarized in the table below:
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Structure	Slab Thickness (ft) (2085 1% AEP)
Elliot Jones	6
Humphreys Canal	6
Shell Canal West	6
Marmande Canal	6
Four Point Bayou	6

5.5 Gate Pile Foundation

The pile foundations for the 20-foot and 30-foot stop log gates will include 30 HP14x73 and 49 HP14x73 piles, respectively, each battered on 3V/1H. Pile capacities were based on the use of compression pile testing, but no tension pile testing. Tension hooks will be provided on all piles. The tip elevations were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. Alternative pile types and arrangements will be investigated during detailed PED design for each structure to optimize the pile foundation.

5.6 Cut-off Wall

A cut-off sheetpile wall will be provided to reduce possible seepage, scouring and uplift. A PZC-13 sheetpile meeting the requirements of ASTM A572, Grade 50 was assumed for the cut-off wall. Tip elevations from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

5.7 Gate

The stop log gates will consist of horizontal wide-flanges supporting the vertical intercostals and skin plate. All connections will be welded connections. A crane mounted on an adjacent T-Wall will be used to lower the gate in place. All steel members on the gate will be painted with a coal tar epoxy paint system.

5.8 Crane Platform T-Wall

The crane platform T-Wall will be located adjacent to the stop log gate monolith and functions as a T-Wall with the addition of a crane load imposed on the monolith. The crane platform wall quantities were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. The crane platform base slab thickness from the 3% AEP PACR was used for the new 2085 1% AEP elevation.

5.9 Needle Girders and Needles

The needle girder system arrangement was designed to dewater the entire gatebay to permit maintenance of the sluice gate concrete gatebay if necessary. The needle girder system was designed for a sill elevation of -8.0 with a water elevation of +5.0. Each stop log gate structure will utilize existing steel needles from other structures in the Morganza to the Gulf alignment as it is not anticipated that maintenance dewatering will be necessary during the design life of the structure. The needles are supported by the sill of the concrete gatebay and the needle girder at El +5.0. The needle girder was designed as a simply supported, built-up girder, spanning across the 20-foot or 30-foot gate opening. The girder will be a plate girder with a depth of 2'1-1/2" with a 5/8-inch web and 3/4-inch by 12-inch flanges. The design and quantities from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

5.10 Bulkhead Storage Platform

The bulkhead storage platform for the 20-foot stop log gate structures will be a reinforced concrete structure measuring 22'6" wide by 30'0" long. The structure consists of a 12-inch cast-in-place slab supported by 22-inch wide by 16-inch deep cast-in-place beams, spaced 14'1" on center. The storage platform will be supported by 15 14-inch square precast, pre-stressed concrete (PPC) piles.

The bulkhead storage platform for the 30-foot stop log gate structures will be a reinforced concrete structure measuring 22'6" wide by 30'0" long. The structure consists of a 15-inch cast-in-place slab supported by 22e by 24" cast-in-place beams, spaced 19'1" on center. The storage platform will be supported by 15 14-inch square precast, pre-stressed concrete (PPC) piles. The design and quantities from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

5.11 Guidewalls and Pile Clusters

Guidewalls and pile clusters will be provided as aids to navigation and to protect the main flood gate structure from impact. Details were taken from historical 56-foot sector gate structures constructed in the New Orleans District rather than performing actual design on this component. The quantities from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

6.0 Environmental Control Structures

This section contains a summary of work for the 21 environmental control structures, which are part of the Morganza to the Gulf Alignment for the 1% AEP level of protection. The table below**Error! Reference source not found.** lists the structures examined.

Structure	Culvert Type	Sill Elevation	Design El (ft)
Barrier 1	6 – 6' X 6'	-4.5	17.0
Barrier 2	6 – 6' X 6'	-4.5	17.0
Barrier 3	6 – 6' X 6'	-4.5	17.0
Barrier 4	6 – 6' X 6'	-4.5	17.0
Barrier 5	6 – 6' X 6'	-4.5	17.0
Barrier 6	6 – 6' X 6'	-4.5	17.0
Barrier 7	6 – 6' X 6'	-4.5	17.0
Reach A	6 – 6' X 6'	-4.5	16.5
Reach E-1	9 – 6' X 6'	-4.5	20.0
Reach E-2	9 – 6' X 6'	-4.5	21.0
Reach G-2 - 1	6 – 6' X 6'	-4.5	20.5
Reach G-2 - 2	4 – 6' X 6'	-4.5	20.5
Reach G-3 - 1	4 – 6' X 6'	-4.5	20.5
Reach H-1 – 1	1 – 6' X 6'	-4.5	20.0
Reach H-1 – 2	6 – 6' X 6'	-4.5	20.0
Reach J2 – 1	4 – 5' X 10'	-3.5	25.0
Reach J2 – 2	4 – 5' X 10'	-3.5	25.0

Structure	Culvert Type	Sill Elevation	Design El (ft)
Reach J2 – 3	5 – 5' X 10'	-3.5	25.0
Reach K – 1	2 – 6' X 6'	-4.5	26.0
Reach K – 2	2 – 6' X 6'	-4.5	26.0
Reach L	6 – 6' X 6'	-4.5	24.5
Larose to Lockport 1	3 – 5' X 10'	-3.5	13.0
Larose to Lockport 2	2 – 6.5' X 7.5'	-5.0	13.0

All elevations listed in this text and shown on the Tables and Plates, unless otherwise noted, are in feet, NAVD88.

6.1 Physical Features

The physical features associated with the construction of the environmental control structures are:

- Interior Braced Cofferdam
- Concrete Monolith
- Pile Foundation
- Sluice Gate
- Bulkheads
- Trash Racks
- Wingwalls
- Tie-in T-Walls
- Mechanical Equipment

6.2 Construction Sequencing

All environmental control structures will be constructed approximately in the center of the existing channels. A cofferdam will be constructed, permitting the construction of the environmental control structure concrete monolith and the wingwalls.

6.3 Cofferdams

A cofferdam will be constructed to permit the in the dry construction of the environmental control structure. The cofferdam is an internally braced cofferdam with wide flange walers and pipe braces supporting PZ sheet piling. Anchor forces, bending moment in the sheet piling, and required sheet piling tip elevation calculated for Bayou du Large sector gate during the development of the PACR were conservatively used for the environmental control structures.

6.4 Walls & Base Slab

The ECS wall quantities were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. The base slab thickness from the 3% AEP PACR was used for the new 2085 1% AEP elevation.

6.5 Pile Foundation

The pile foundation for the environmental control structures will include HP14x73 piles battered on 3 vertical to 1 horizontal slope. Pile capacities were based on the use of compression pile testing, but no tension pile testing. Tension hooks are provided on all piles on the flood side of the sheet pile cutoff. The tip elevations were pro-rated based on the elevation difference between the 3% AEP quantities developed from the PACR and the new 2085 1% elevation. Alternative pile types and arrangements will be investigated during detailed design for each structure to optimize the pile foundation.

6.6 Cut-off Wall

A cut-off sheetpile wall will be provided to reduce possible seepage, scouring and uplift. A PZC-13 sheetpile meeting the requirements of ASTM A572, Grade 50 was assumed for the cut-off wall. Tip elevations from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

6.7 Sluice Gates

The sluice gates will be manufactured 6’ by 6’, 5’ by 10’, 6.5’ by 7.5’ or 5’ by 10’ cast iron gates.

6.8 Bulkheads

The bulkheads were designed to dewater the sluice gate bays to permit maintenance of the sluice gates and concrete gatebay. The bulkheads were designed for a sill elevation of -4.5 with a water elevation of +5.0. Each sluice gate structure will be provided with two bulkheads, permitting the dewatering of 1 sluice gate bay at a time. The design and quantities from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

6.9 Trash Racks

Trash racks will be provided on both the flood and protected sides of the sluice gates to prevent large debris from blocking the closure of the sluice gates. The tracks will be constructed of galvanized steel plate conforming to the requirements of ASTM A572, Grade 50. The design and quantities from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

6.10 Wingwalls

Wingwalls will be provided on all 4 corners of the environmental control structure to retain fill and to provide a smooth flow transition into the environmental control structures. The wingwalls are pile founded T-Wall type concrete monoliths. The wing walls will be supported on HP14x73 steel piling, whose tips will be extended to the same tip elevation of the environmental control structure pile tips to prevent differential settlement. The design and quantities from the 3% AEP PACR structures were used for the new 2085 1% AEP elevation.

7.0 Pump Station Fronting Protection

This section contains a summary of work for the four pump station fronting protections. The table below lists the structures examined.

Pump Station	Pump Sizes	Design El (ft)
Madison	2 – 48”	25.0
Pointe Aux Chenes	2 – 20”	23.5
Bayou Black	2 – 42”	17.0
Hanson Canal	2 – 42”	17.0

7.1 Physical Features

The physical features associated with the construction of the pump station fronting protection are:

- Fronting Protection T-Walls
- Mechanical Equipment – Butterfly Valves

7.2 Construction Sequencing

All fronting protections will be constructed on the flood side of the existing protection. Based on site visits conducted for this report, the discharge pipes extend far enough such that additional pipe length will not be needed.

7.3 Fronting Protection Walls

All fronting protection walls were designed as T-Walls as described herein

8.0 Roadway/Railroad Gates

This section contains a summary of work for the ten roadway/railroad swing gates. The table below lists the structures examined.

Roadway	Gate Opening (ft)	Design El (ft)
Hwy 315	36	21.0
Hwy 55	36	25.0
Hwy 56	36	20.0
Hwy 665	36	23.5
NAFTA	36	17.0
Four Point Road	36	19.5
Hwy 24	36	16.5
Hwy 3235 - 1	36	16.5
Hwy 3235 - 2	36	16.5
Union Pacific RR	36	13.0

8.1 Physical Features

The physical features associated with the construction of the roadway gates structures are:

- Steel Swing Gate
- Traffic Control Devices
- Falsework (Railroad Gates)
- Concrete Monolith
- Tie-in T-Walls

8.2 Construction Sequencing

All roadway gates except for the NAFTA gate are directly adjacent to navigation gates; therefore, they will be constructed concurrent with those structures. The roadway gate concrete monoliths will be constructed in two halves to permit traffic flow during construction of the concrete monoliths. Detours and traffic control will conform to LADOTD Standards. Railroad gates will be constructed with temporary falsework to minimize disruptions to the railroad during construction

8.3 Steel Swing Gates

The structural design of the steel swing gates was performed in accordance with Corps engineering guidance and applicable industry standards. The swing gates will consist of structural wide flange sections supporting the vertical ribs and skin plate. All connections will be welded connections. All steel members on the gate will be painted with a vinyl paint system. The swing gates were re-designed for the new 2085 1% AEP.

8.4 Skin Plate

The skin plate was designed conservatively as a continuously supported member by vertical intercostals. An allowable stress of 0.50 times the yield stress was permitted for basic loading conditions with a permissible increase of one-third for abnormal loading conditions.

8.5 Vertical Intercostals

The skin plate will be attached to the vertical intercostals by continuous welds. The intercostals were designed as simply supported members between the horizontal girders. The skin plate was considered as an effective part of the vertical intercostals, with the effective width of skin plate determined according to the AISC specifications for a non-compact flange. A minimum depth of 8 inches for the intercostals is required to facilitate painting and maintenance. The intercostals will be constructed from steel material conforming to ASTM A572, Grade 50.

8.6 Horizontal Beams

The gate will consist of horizontal wide flange sections supporting the vertical intercostals and skin plate. The beam was designed as simply supported between the concrete pilasters of the swing gate monolith. The beams are constructed from steel material conforming to ASTM A992.

8.7 Concrete Monolith and Pile Foundation

The swing gate concrete monolith and pile foundation was not designed; rather the typical T-Wall design as described herein for other structure components was utilized for quantity estimation.

8.8 Traffic Control Devices

Each roadway gate will include guardrails meeting the requirements of LADOTD GR-200 and end treatment on all four sides of the structure. Removable Vulcan barriers will be provided as guardrails in the gate swing radius.

9.0 Pipeline Crossings

This section contains a summary of work for the three pipelines crossing T-Walls. The table below lists the structures examined.

Pipeline	Top Elevation (2085 1% AEP)
C North Gulf South Pipeline	16.5
C North American Midstream Pipeline	16.5
C North Williams Discovery Pipeline	16.5

9.1 Physical Features

The physical features associated with the construction of the pipeline crossing structures are:

- Utility Crossing T-Wall
- Utility Sleeve
- Cofferdam
- Tie-in T-Walls (Union Pacific Railroad Gate Only)

9.2 Construction Sequencing

A cofferdam will be constructed to construct the sleeve of the pipeline crossing through the T-Wall.

9.3 T-Wall Concrete Monolith and Pile Foundation

The utility crossing concrete monolith and pile foundation was not designed, rather the typical T-Wall design as described earlier herein was utilized for quantity estimation.

9.4 Cofferdam

The cofferdam design as described earlier herein was used to develop quantities for the cofferdam required to construct the pipeline crossing sleeve.

9.5 Tie-in T-Walls

Tie-in T-Walls extend from the utility crossing T-Wall to the full levee section. T-walls shall be designed as described earlier herein for other structural feature.