APPENDIX P: FLOOD AND STORM HAZARDS EVALUATION

P1: Surge and Wave Conditions Report (ADCIRC Model)

P2: Coastal Water Surface Elevations Report

P1: Surge and Wave Conditions Report (ADCIRC Model)

Mid-Barataria Sediment Diversion Project EIS

Appendix P: Surge and Wave Conditions

Final

October 5, 2020

US Army Corps of Engineers®
New Orleans District

GEC

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The purpose of this appendix is to describe the surge and wave modeling efforts undertaken by CPRA in support of the Mid-Barataria Sediment Diversion (MBSD) Environmental Impact Statement (EIS) prepared by the U.S. Army Corps of Engineers (USACE). Arcadis led the modeling efforts for CPRA and used the previously validated surge and wave models developed for the 2017 Coastal Master Plan (CPRA 2017; White et al. 2017) to estimate the impact that the MBSD Project may have on future surge and wave levels (Arcadis 2019). The ADvanced CIRCulation (ADCIRC) and Simulating Waves Near-shore (SWAN) models were used to compute storm surge and wave respectively in the study area and its vicinity. The ADCIRC is the state-of-the-art model used to perform hydrodynamic computations. The coupled ADCIRC and SWAN models (ADCIRC+SWAN) have been successfully used in many previous CPRA studies of the Louisiana coast, Federal Emergency Management Agency (FEMA) RiskMAP studies, and other organizations. The report produced for this ADCIRC+SWAN analysis is henceforth referenced and referred to in this appendix as the MBSD ADCIRC Report.

2.0 MODELING APPROACH

2.1 Model Description

The ADCIRC model was developed as part of the USACE Dredging Research Program (Luettich et al. 1992, Westerink et al. 1992). ADCIRC is a physics-based model and is capable of simulating storm surge propagation and tidal circulation over large domains. The model uses a finite element algorithm to perform accurate and efficient computations over high resolution complex shoreline configuration and bathymetry. The model is formulated with the depth averaged shallow water equations for conservation of mass and momentum. The formulation assumes that the water is incompressible, hydrostatic pressure conditions exist, and the Boussinesq approximation is valid. Using the standard quadratic parameterization for bottom stress and neglecting baroclinic terms and lateral diffusion/dispersion effects results in a set of conservation equations in primitive, nonconservative form (Flather 1988, Kolar et al. 1994, Westerink et al. 2008). The momentum equations are spatially differentiated and substituted into the time-differentiated continuity equation to develop the generalized wave-continuity equation (GWCE).

ADCIRC solves the GWCE in conjunction with the primitive momentum equations. The GWCE-based solution scheme eliminates several problems associated with finite element programs that solve the primitive forms of the continuity and momentum equations, including spurious modes of oscillation and artificial damping of the tidal signal. Forcing functions include time-varying, water surface elevations, wind-shear stresses, atmospheric pressure gradients, and the Coriolis acceleration effect. Also, the study area can be described in ADCIRC using either a Cartesian (that is, flat earth) or spherical coordinate system.

The ADCIRC model uses a finite element algorithm in solving the defined governing equations over complicated bathymetry encompassed by irregular sea/shore boundaries. This algorithm allows for extremely flexible spatial discretization over the entire computational domain and has demonstrated excellent stability characteristics. The advantage of this flexibility in developing a computational mesh is that larger elements can be used in open-ocean regions where less resolution is needed whereas smaller elements can be applied in the nearshore and estuary areas where finer resolution is required to resolve hydrodynamic details (Hagen et al. 2001).

The ADCIRC model was coupled with the SWAN wave model which is a third-generation numerical wave model able to resolve wave propagation processes along with wave generation by wind, wave dissipation, refraction, shoaling and nonlinear wave-wave interactions. SWAN is a spectral wave model which predicts the wave action density spectrum and provides realistic estimates of wave parameters such as wave height, period and direction in coastal areas, lakes and estuaries for given wind, bottom and current conditions. The model is based on the spectral action balance equation and is unconditionally stable to the use of a fully implicit numerical propagation scheme. A detailed description of the SWAN model can be found in papers by Booij et al. (1999), Ris et al. (1999), and Holthuijsen et al. (2003).

2.2 Storm Selection

The storm events used in the analysis are a subset of the synthetic storm suite developed by the FEMA for assessing coastal flood risk (USACE 2008a, b). The FEMA synthetic storm suite consists of 446 storm events for the Louisiana coast, covering a wide range of intensities and probabilities. The synthetic storm suite consists of two sets of 152 high intensity storms and two sets of 71 low intensity storms for eastern and western Louisiana. The synthetic storms were selected by considering the probable combination of central pressure, radius of maximum winds, translation speed, heading, and track.

Each storm in the total FEMA synthetic storm suite is identified by a unique integer number. The storm-numbering convention identifies the geospatial landfall location and intensity as follows: Storm ID 1-162 for East Louisiana (152 total); ID 201-362 for West Louisiana (152 total); ID 401-471 for Low Intensity West events (71 total); and ID 501-571 for Low Intensity East events (71 total). As such, the FEMA storm suite encompasses a variety of storm intensities and contains storms that impact a wide geographic region, with the goal of quantifying the annual exceedance probability (AEP) along the entire coast for the 10 percent (10-year return period) to the 0.2 percent (500-year return period) events (USACE 2008a, b).

To examine trends in the impacts on storm surge and waves associated with diversion alternatives, it was not necessary to perform simulations for the full FEMA storm suite. Rather, a subset of relevant storm events was selected to more efficiently assess only the 4 percent and 1 percent AEP events (that is, the 25- and 100-year return period storm conditions) which would hypothetically impact the Project area. The methodology for selecting the storms from the full storm suite included the use of 63 sampling locations evenly distributed throughout the Project area (see Figure 2-1).

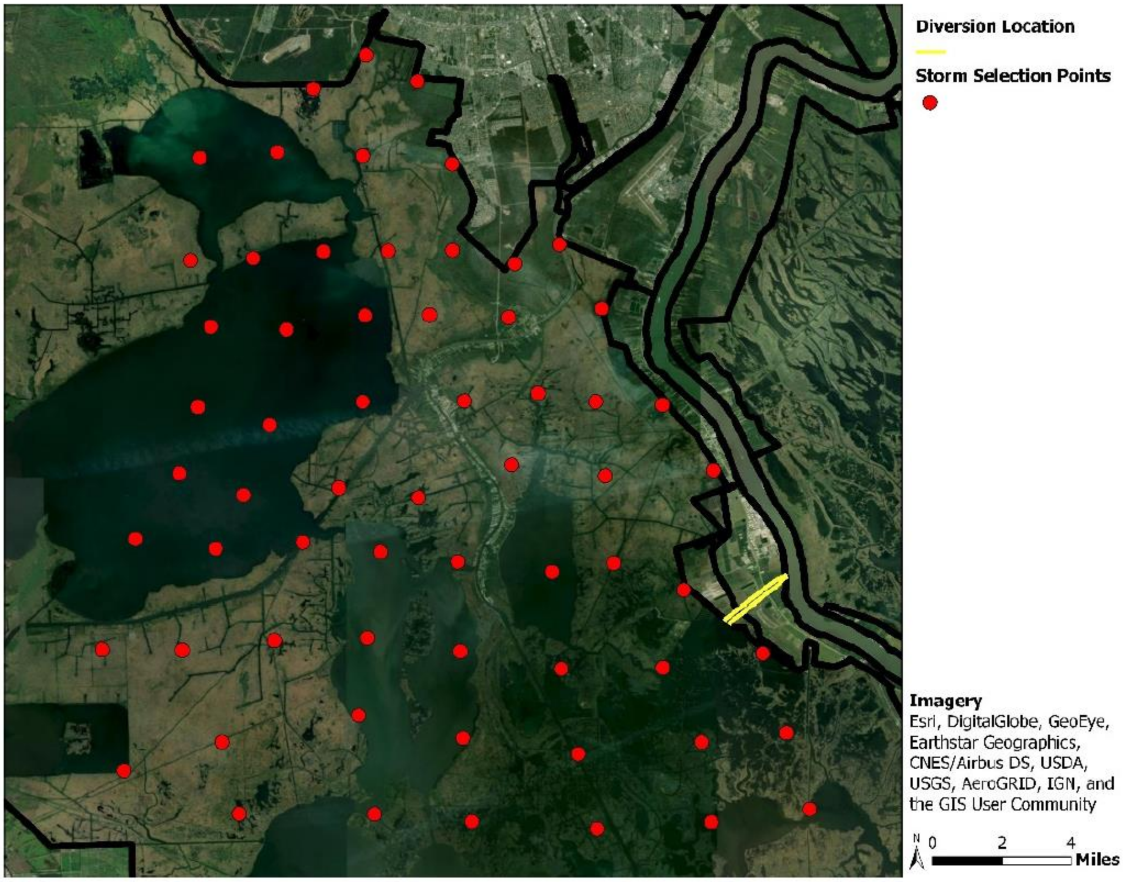


Figure 2-1. Project Area Sample Locations Used for Storm Selection.

The 4 percent and 1 percent AEP stillwater elevations were then identified for each location from the original FEMA study (USACE 2008a, b). The database of existing results from previous simulations for each FEMA storm was queried to identify the peak storm surge elevation generated at each location for each storm. The suitability of each synthetic storm was evaluated by computing the root mean square (RMS) difference for the 4 percent and 1 percent surge elevations across all sample locations. The subset of storms was selected to reduce the overall RMS differences (with one grouping compared to the 4 percent AEPs and another to the 1 percent AEPs) and to span a range of storm parameters, such as forward speed, minimum pressure, and track azimuth. The selected 4 percent AEP storms are listed in Table 2-1, and the storm tracks are shown on Figure 2-2. The selected 1 percent AEP storms are listed in Table 2-2, and the storm tracks are shown on Figure 2-3.

Table 2-1
Storms Selected to Approximate 4 Percent AEP Surge Elevation

FEMA Study Storm Identifier	Pressure (millibar)	Forward Speed (Knot)	Radius (nautical Mile)
011	960	11	21
101	930	17	18
239	960	11	36
257	960	11	18

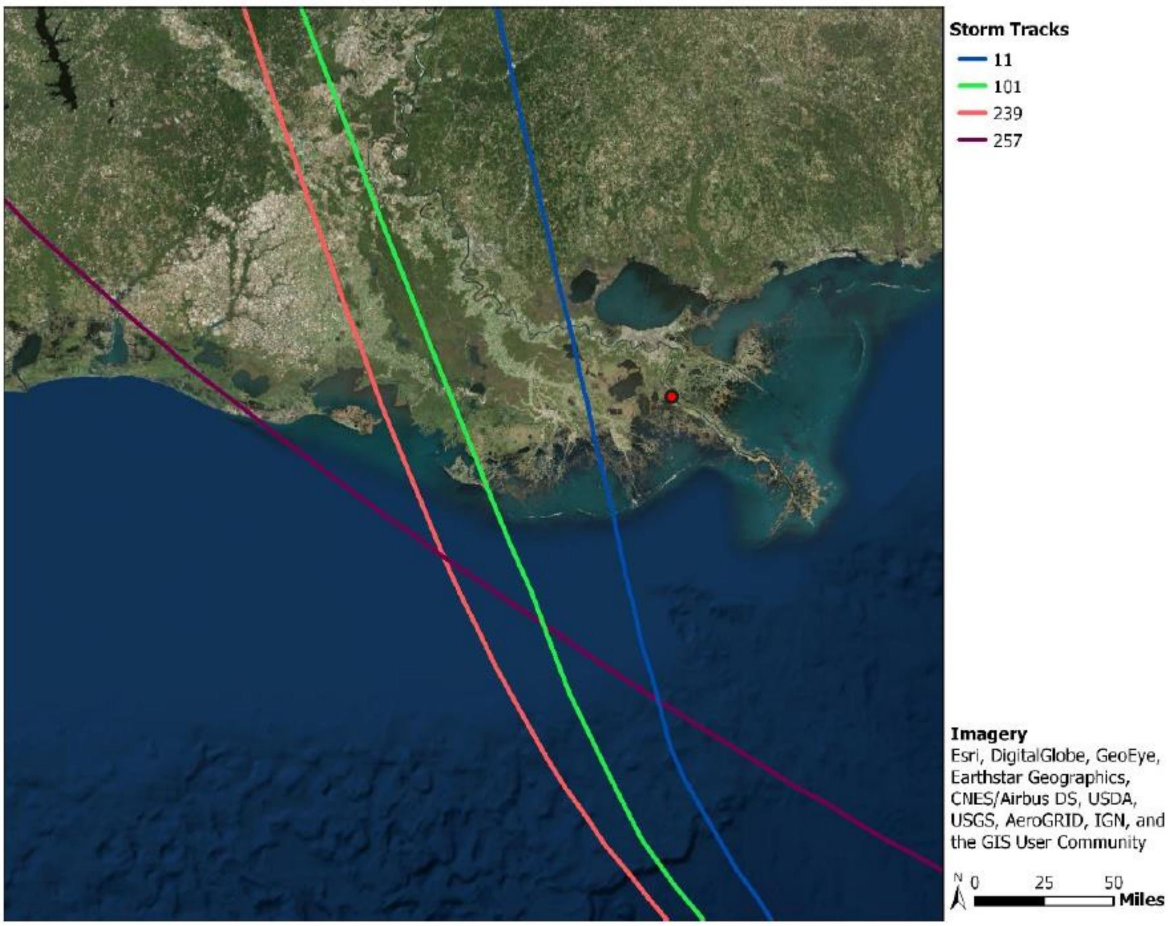


Figure 2-2. 4 Percent AEP Storm Tracks.

Table 2-2 Storms Selected to Approximate 1 Percent AEP Surge Elevation			
FEMA Study Storm Identifier	**Pressure (millibar)**	**Forward Speed (Knot)**	**Radius (nautical Mile)**
009	900	11	21
014	930	11	17
093	930	6	17
160	930	17	17
245	900	11	22

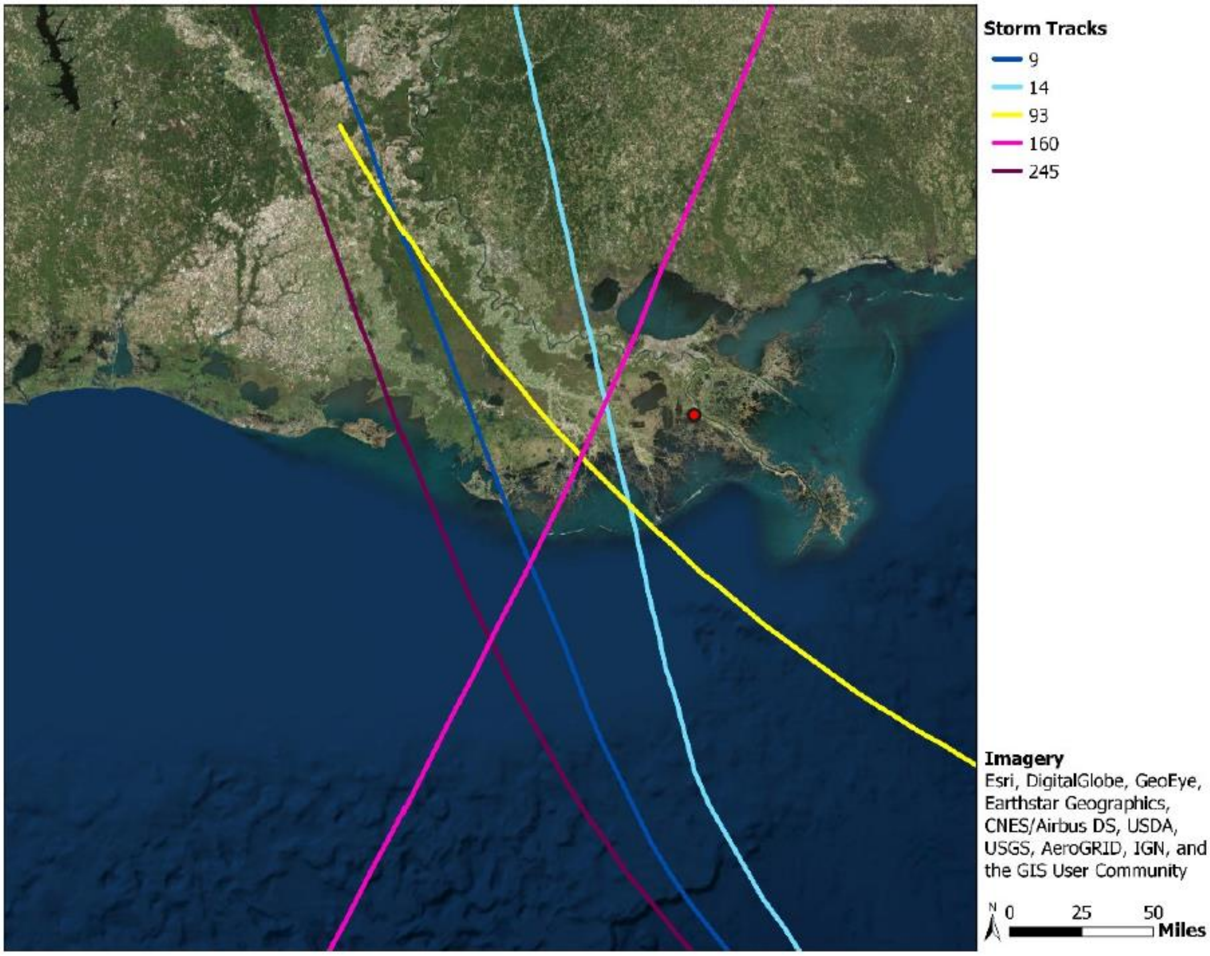


Figure 2-3. 1 Percent AEP Storm Tracks.

Two additional storm events were added to the storm suite to understand how surge and wave activity during slow-moving storms are impacted by the proposed diversion alternatives. The first slow-moving storm, Storm 011-Slow was created by decreasing the average forward speed of Storm 011, one of the selected 4 percent AEP storms, from 11 knots to 7 knots. The second slow-moving storm was based on the actual Hurricane Isaac from 2012 which had an average forward speed of 7 knots as it approached Barataria Basin. Oceanweather Inc. developed wind speed and air pressure input files based on the meteorological observations collected during

Hurricane Isaac. These input files were used to simulate a storm event like Hurricane Isaac.

2.3 Mesh Development

In order to capture details of the evolving landscape in Barataria Basin, the 2017 Master Plan model resolution was increased in the area of interest. By decreasing the size of individual finite elements (triangular cells over which a set of equations are solved) and thereby increasing the number of elements, improved representation of the landscape was achieved. Figure 2-4 shows the resolution of the 2017 Master Plan model, and Figure 2-5 shows the resolution of the Mid-Barataria mesh by contouring the size of the finite elements within Barataria Bay adjacent to the diversion. Note the area near the Gulf Intracoastal Waterway and west of the Mississippi River where element size was decreased from 500 to 1,000 feet to 250 to 500 feet for the Mid-Barataria model. This increase in resolution better captured topographic and friction changes resulting from the diversion with only a small increase in computational effort. Additionally, the diversion conveyance channel was added to the mesh geometry to allow propagation of surge and waves into the channel itself and to allow diversion flow rates to be considered in the model for the sensitivity analysis.

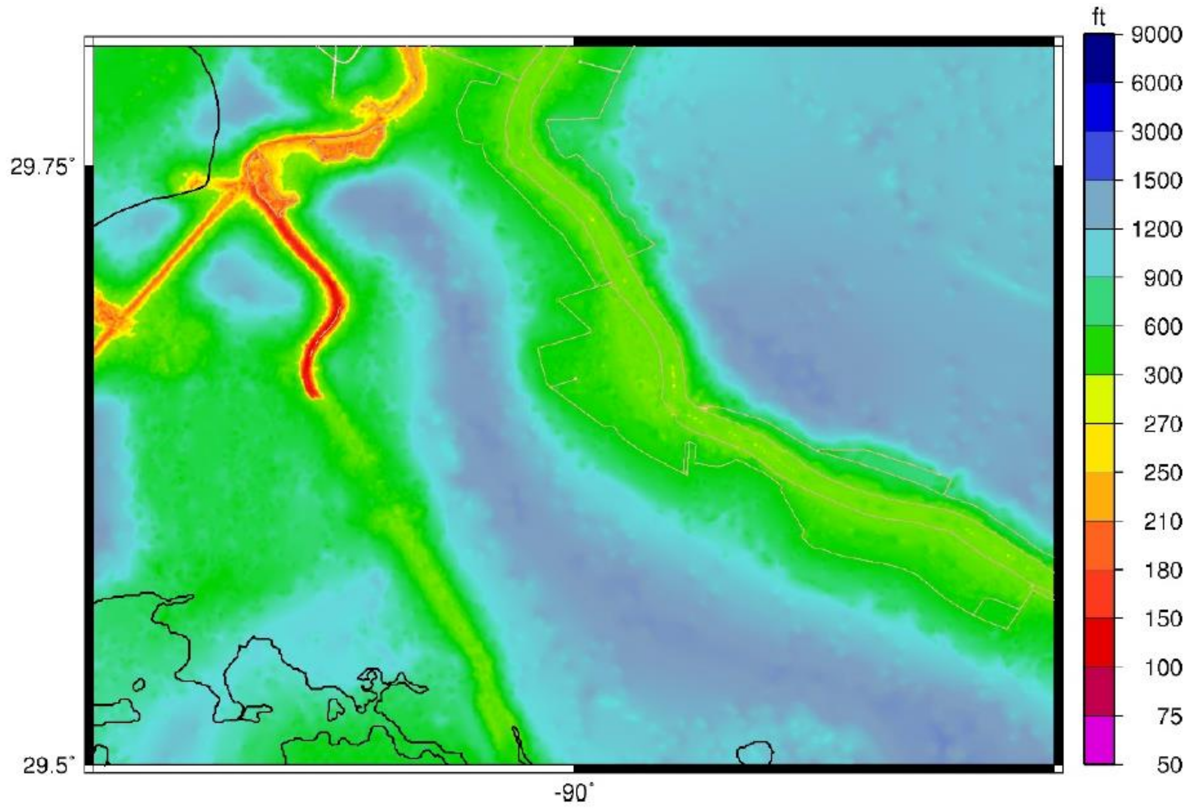


Figure 2-4. Mesh Resolution for the 2017 Master Plan Model.

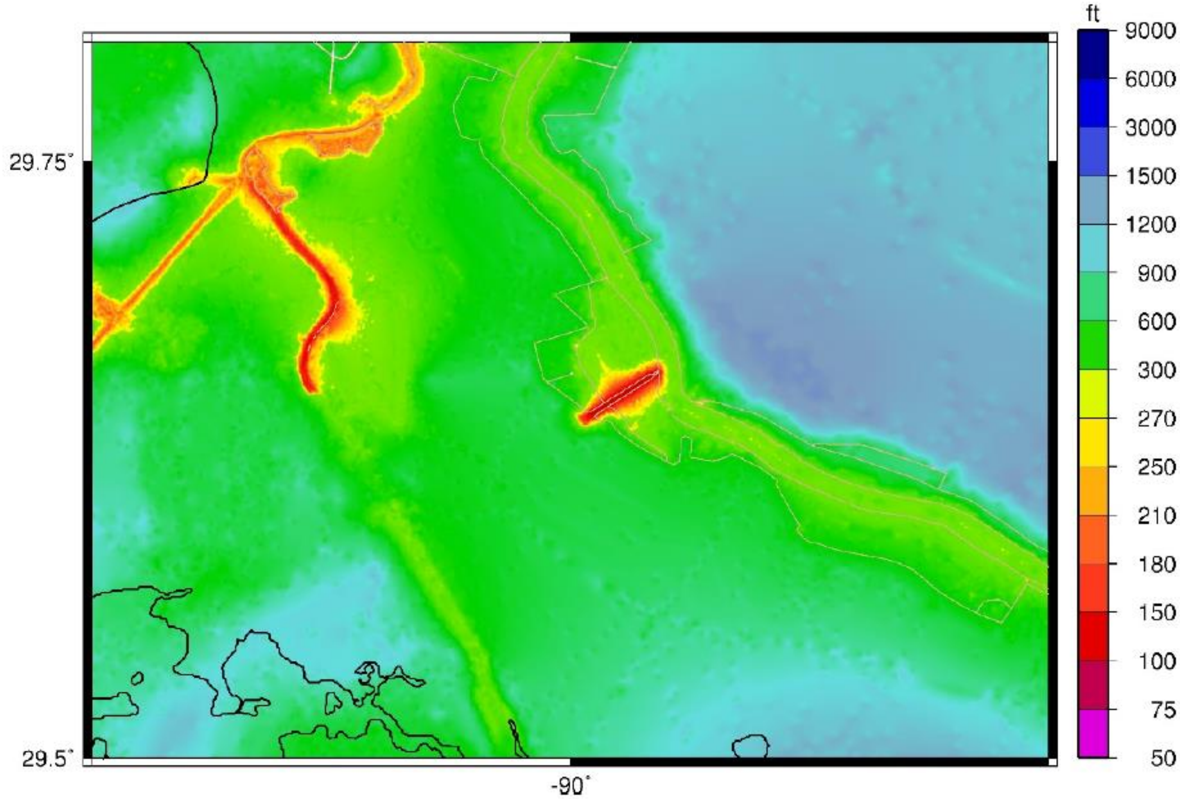


Figure 2-5. Mesh Resolution for the Mid-Barataria Sediment Diversion ADCIRC Model.

The Project area encompasses four major federal levee systems:

- West Bank and Vicinity Hurricane and Storm Damage Risk Reduction System (WBV HSDRRS);
- Mississippi River and Tributaries (MR&T);
- New Orleans to Venice (NOV), including non-federal levees currently being incorporated into the NOV system (NOV-NFL); and
- Larose to Golden Meadow (LGM).

Each system consists of one or more levee sections with unique requirements for current and future design elevations to achieve and maintain an authorized level of risk reduction as provided through coordination with USACE. Categories are summarized in Table 2-3 and can be seen in Figure 2-6. In order to capture current and future levee elevations within the model, levees in sections with known future authorized elevations were interpolated upward linearly in time for the three sea-level rise scenarios (2020, 2040, and 2070) from the design elevation at the current year (2017) to a future year and capped at the future authorized elevation. Levee elevations in the MR&T Flowline section were assumed static over time (that is, maintained to a constant elevation). Levees outside of the WBV, NOV, and MR&T systems retained elevations from USACE surveys taken between December 2000 and November 2014. Final levee elevations used in the model were defined as the maximum interpolated value amongst any overlapping levee sections and their corresponding survey elevation. Subsidence was not applied to the levees as they were assumed to be maintained to current or design elevations into the future.

Table 2-3
Levee Categories

Levee System	Levee Sections	Current Year	Future Year	Methodology
WBV HSDRRS	HSDRRS	2007	2057	Interpolated
MR&T	Flowline	-	-	Static
	1% Surge	2013	2063	Interpolated
NOV and NOV-NFL	2% Design	2013	2063	Interpolated
	4% Design			
	Prior Alignment			
	Updated Alignment			

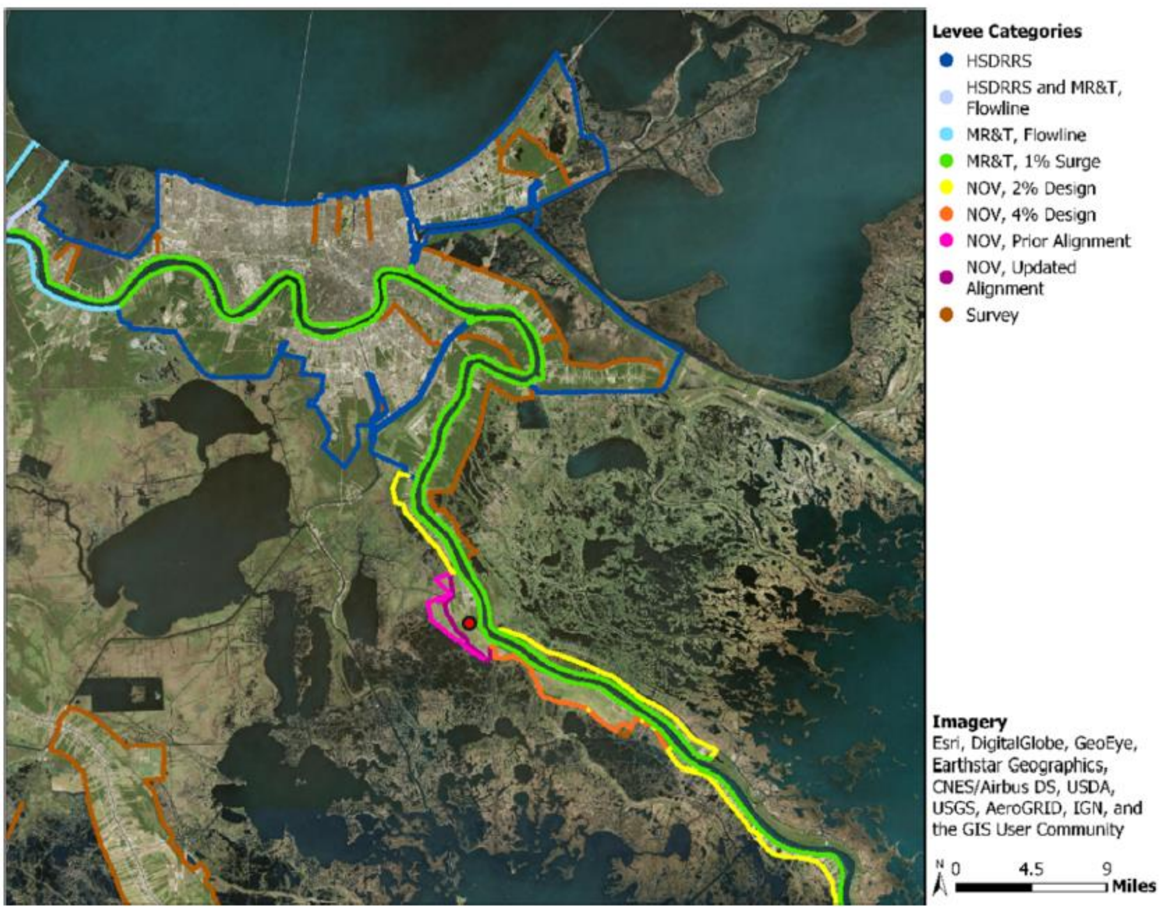


Figure 2-6. Levee Data Sources Used in ADCIRC+SWAN Model.

2.4 Alternative Simulations and Sensitivity Analyses

This MBSD ADCIRC+SWAN study primarily focuses on the Applicant's Preferred Alternative (75,000 cfs Alternative) and No Action Alternative. Additionally, a sensitivity analysis was completed to understand the impact of each additional alternative listed below, as well as an open conveyance channel design and No Action Alternative in combination with other reasonably foreseeable future planned projects in the region. A limited set of simulations was used for the sensitivity analysis to provide a general understanding of the impact of each alternative other than the Applicant's Preferred Alternative. Unlike the analysis completed for the Applicant's Preferred Alternative, only a subset of storm events was modeled for each alternative in the sensitivity analysis. Reducing the number of storm events allowed for more alternatives to be reviewed without requiring significant additional computational time and resources. The following alternatives and scenarios were simulated for this study:

- No Action Alternative: No diversion would be permitted;
- 75,000 cfs Alternative (Applicant's Preferred Alternative);
- 50,000 cfs Alternative;
- 150,000 cfs Alternative;
- No Action + Terraces Alternative;
- No Action + Reasonably Foreseeable Other Projects;
- 150,000 cfs + Reasonably Foreseeable Other Projects;
- Open Outfall Conveyance Channel Design;
- Outfall Gate partially open during storm event; and
- Outfall Gate open during storm event.

The additional capacity alternatives (50,000 cfs Alternative and 150,000 cfs Alternative) were set up as follows:

- Features Different from the Applicant's Preferred Alternative (75,000 cfs) simulation:
    - A diversion capacity of 50,000 cfs, which alters elevation and land-cover features for future conditions, as described by Delft3D Basinwide Model outputs; and
    - A diversion capacity of 150,000 cfs which alters elevation and land-cover features for future conditions, as described by Delft3D Basinwide Model outputs.

- Features Unchanged from the Applicant's Preferred Alternative (75,000 cfs) simulation:
    - A continuous line of protection along the existing NOV levee system resulting in a closed conveyance channel;
    - A completely closed diversion intake system during the storm event;
    - An initial water level equal to the September 2017 mean sea level plus the sea-level rise to account for 2020, 2040, and 2070 conditions; and
    - The exclusion of terraces and other future planned projects.

To understand the impact of terraces, terraces were added to the 2020 current conditions to isolate the influence of terraces only, as follows:

- Features Different from the Applicant's Preferred Alternative (75,000 cfs) simulation:
    - The inclusion of terraces without planned projects, which alters elevations and land-cover inputs to the model; and
    - The exclusion of diversion and associated elevation and land-cover changes. This element is identical to the No Action Alternative setup.
- Features Unchanged from the Applicant's Preferred Alternative (75,000 cfs) simulation:
    - A continuous line of protection along the existing NOV levee system resulting in a closed conveyance channel; and
    - An initial water level equal to the September 2017 mean sea level plus the sea-level rise to account for 2020, 2040, and 2070 conditions.

Delft3D Basinwide Model results from the cumulative impacts model run were used to update the ADCIRC+SWAN model to account for changes in ground elevations and roughness coefficients in the study area due to the planned projects. All planned projects from the Delft3D Basinwide Model cumulative impacts run were included in the analysis. The list of reasonably foreseeable projects in the Delft3D Basinwide Model includes:

- Mid-Breton Sediment Diversion (BS-0030);
- Spanish Pass Ridge and Marsh Restoration (BA-0191);
- Bayou L'Ours Marsh Terracing;
- NOV-NFL drainage relocation project;

- Northwest Turtle Bay Marsh Creation (BA-0125);
- Barataria Basin Ridge and Marsh Creation – Spanish Pass Increment (BA-203);
- Barataria Large-Scale Component E – Planning (BA-0192);
- Caminada Headlands Back Barrier Marsh Creation (BA-0717);
- Bayou Grande Cheniere Marsh and Ridge Restoration (BA-0173);
- Caminada Headlands Back Barrier Marsh Creation Increment 2 (BA-0193);
- East Leeville Marsh Creation and Nourishment (BA-0194);
- Barataria Bay Rim Marsh Creation and Stabilization (BA-0195); and
- West Grand Terre Beach Nourishment and Stabilization (BA-0197).

To understand the impact of two different designs of the Applicant's Preferred Alternative (open vs. closed conveyance channel on the outfall end), the design was altered to include an open conveyance channel. The simulation setup was as follows:

- Features Different from the Applicant's Preferred Alternative (75,000 cfs) simulation:
    - The inclusion of an open conveyance channel.
- Features Unchanged from the Applicant's Preferred Alternative (75,000 cfs) simulation:
    - A diversion capacity of 75,000 cfs, which alters elevation and land-cover features for future conditions, as described by Delft3D Basinwide Model outputs;
    - A completely closed diversion intake system during the storm event;
    - An initial water level equal to the September 2017 mean sea level plus the sea-level rise to account for 2020, 2040, and 2070 conditions; and
    - The exclusion of terraces and other future planned projects.

Two additional diversion scenarios were modeled to understand the impacts of leaving the conveyance channel of the diversion open prior to and during a storm event. First, two 1 percent AEP storm events (Storms 093 and 160) were simulated with the September mean sea level and the 75,000 cfs diversion partially closed to only allow 30,000 cfs during the storm. Second, two 4 percent AEP storm events (Storms 011 and 101) were simulated with average June mean sea levels and the 75,000 cfs diversion left completely open. The model setup for all other simulations in this study assumed a September mean sea level, which is 0.36 foot higher than the June mean sea level. All simulations completed for this sensitivity analysis used 2040 future conditions. The model setup for these scenarios was as follows.

- Features Different from the Applicant's Preferred Alternative (75,000 cfs Alternative):
    - Two diversion scenarios alter the status of the diversion intake gate:
        - 75,000 cfs Alternative Partially Open: Diversion intake gate is partially open to allow flow rate of 30,000 cfs; and
        - 75,000 cfs Alternative Completely Open: Diversion intake gate is completely open to allow flow rate of 75,000 cfs.
    - Initial water levels vary for the two sensitivity analysis alternatives:
        - 75,000 cfs Alternative Partially Open: Initial water level equal to an average September mean sea level, same as the base 75,000 cfs Alternative, for a completely open intake gate alternative. Future sea-level rise added as normal; and
        - 75,000 cfs Alternative Completely Open: Initial water level equal to an average June mean sea level for completely open diversion condition. Future sea-level rise added as normal.
- Features Unchanged from 75,000 cfs Alternative:
    - A diversion capacity of 75,000 cfs, which alters elevation and land-cover features for future conditions, as described by Delft3D Basinwide Model outputs;
    - A continuous line of protection along the existing NOV levee system resulting in a closed conveyance channel; and
    - The exclusion of terraces and other future planned projects.

2.5 Model Input Parameters

The coupled ADCIRC+SWAN model required several input parameters to define the landscape of interest. In particular, the model requires elevation (topography and bathymetry) and surface-roughness parameters (at the sea surface and at the sea floor) specified for each of approximately 1.4 million computational points in the mesh. ADCIRC and SWAN models use the same model inputs and communicate directly at each node in the computational mesh. To appropriately reflect the desired landscape scenarios, sea levels, and levee heights, several parameter values were modified near the Project area, as described below. All other model setup parameters, including the finite element mesh and source code used, were identical to those used during the 2017 Master Plan (Roberts and Cobell 2016). Model simulations were conducted for 2020 (Year 0), 2040 (Year 20), and 2070 (Year 50) to examine the impacts of landscape changes to storm surge and waves over time. These landscape changes were calculated using the Delft3D Basinwide Model results (see Appendix E). The resolutions of the Delft3D Basinwide Model and ADCIRC are similar, but the mesh geometries differ. To ensure the ADCIRC representation of specific features (for example, raised roadways, narrow waterways) was maintained, increments of changes determined in the Delft3D Basinwide Model for topography and bathymetry, bottom friction, and surface roughness were applied to the ADCIRC model. Examples of changes in topography and bathymetry from the 2017 Master Plan to the 2020 base year for this Project are shown on Figure 2-7; examples of changes in bottom friction and surface roughness are shown on Figure 2-8. Sea-level rise was accounted for by raising the model's initial water level to be consistent with water levels used in the Delft3D Basinwide Model simulations. For the ADCIRC+SWAN simulations, 0.13 foot was added to 2017 water levels for 2020 simulations (Year 0), 0.82 foot was added for 2040 simulations (Year 20), and 2.37 feet was added for 2070 simulations (Year 50).

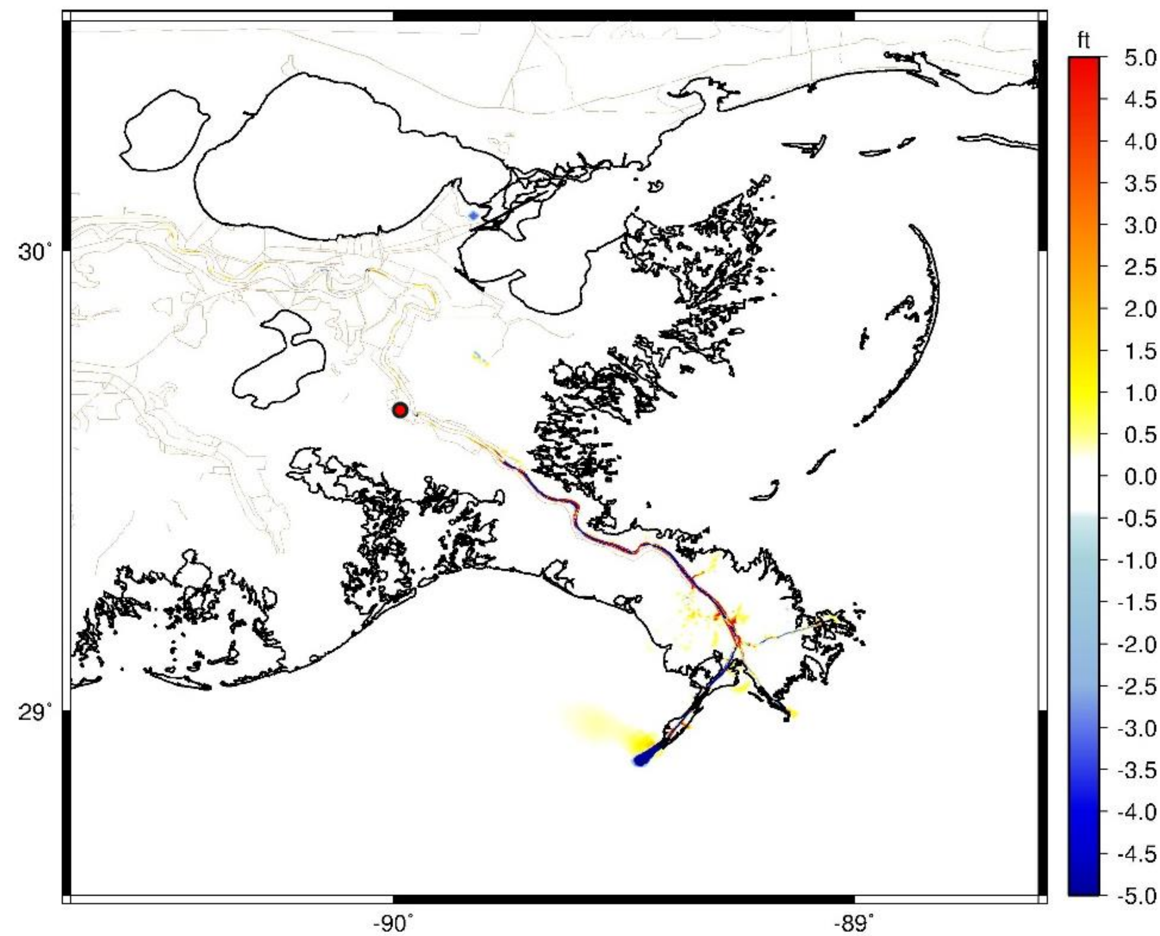


Figure 2-7. Topography and Bathymetry Differences between the 2017 Master Plan Model and the Mid-Barataria Sediment Diversion Model Year 2020.

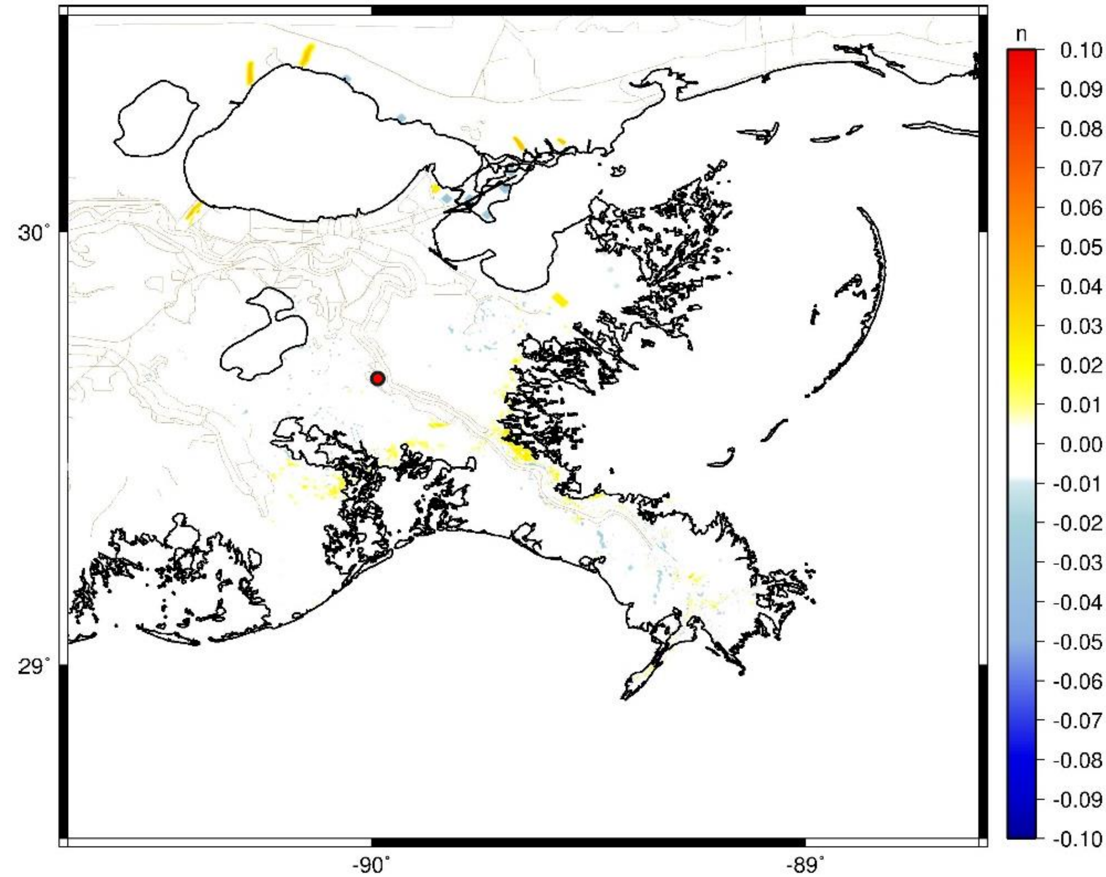


Figure 2-8. Manning's n Differences between the 2017 Master Plan Model and the Mid-Barataria Sediment Diversion Model Year 2020.

3.0 MODELING RESULTS

This section provides detailed ADCIRC+SWAN outputs to supplement the summaries of ADCIRC+SWAN data presented in Section 4.21.3.3 (Public Health and Safety) in Chapter 4 of the EIS. ADCIRC+SWAN produces large volume of data for all the grid points. To facilitate data use and storage, model results are usually recorded at specified stations ("save" points). Figure 3-1 shows the save point locations within the Project area and its vicinity.

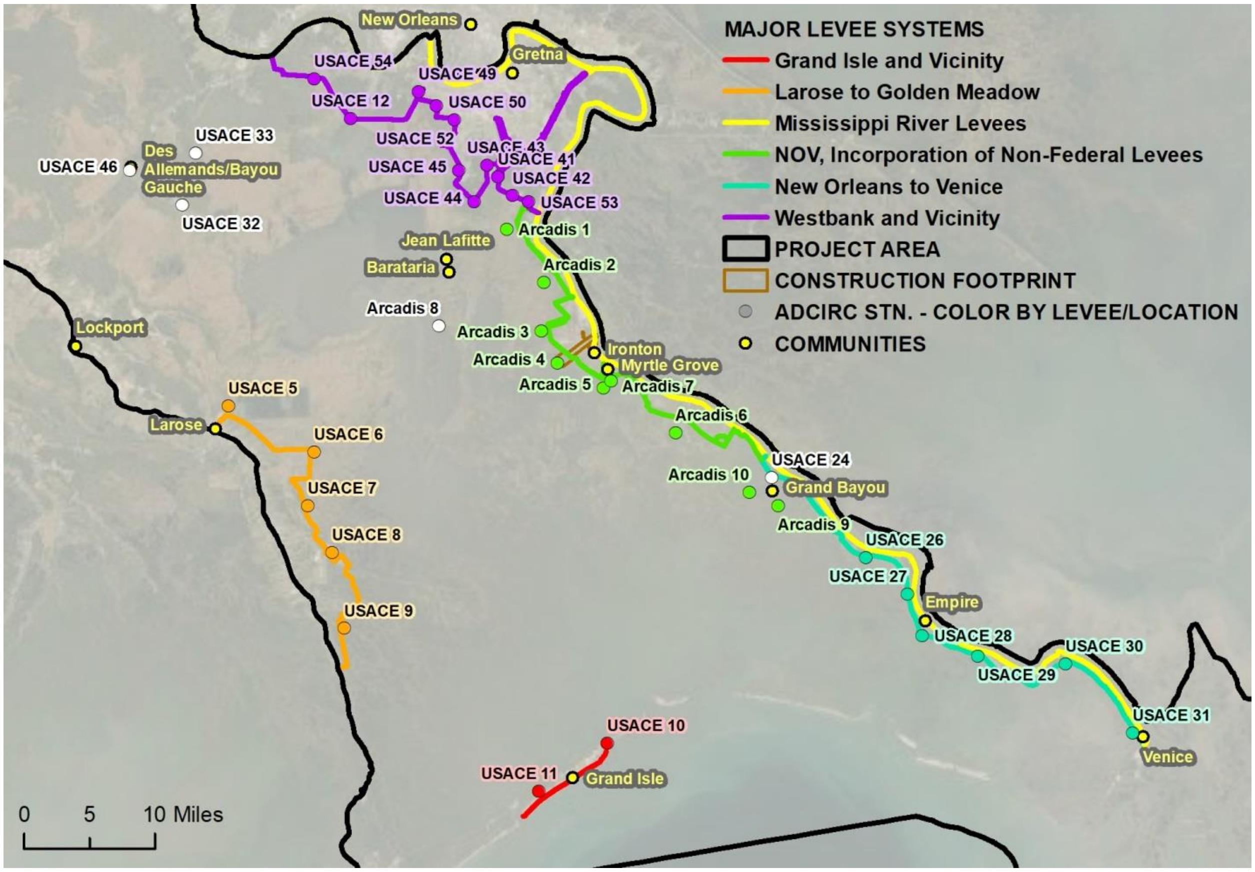


Figure 3-1. Save Point Stations in the Project Area Used for Analysis.

The subsections below contain detail on the following:

- No Action Alternative;
- Applicant's Preferred Alternative;
- Other Alternatives (50,000 cfs and 150,000 cfs);
- No Action + Reasonably Foreseeable Other Projects;
- 150,000 cfs Alternative + Reasonably Foreseeable Other Projects +Terraces; and

- No Action + Terraces.

For the No Action Alternative and Applicant's Preferred Alternative, figures are provided to show the maximum water surface elevation and wave height throughout the basin for each modeled storm in 2020, 2040, and/or 2070. These figures are followed by hydrographs that display the water surface elevation for a representative 1 percent AEP and 4 percent AEP simulated storm at each data extraction, or save point utilized in the development of Tables 4.21-4 through 4.21-15 in Chapter 4 of the EIS. Finally, tables are provided that list the minimum, maximum, and mean surge elevations and wave heights at each save point used in the analysis for 2020, 2040, and/or 2070.

For the 50,000 cfs Alternative, 150,000 cfs Alternative, Other Reasonably Foreseeable Projects, and the 150,000 cfs Alternative + Other Reasonably Foreseeable Projects, tables are provided that list the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP storm selected for analyses of these alternatives, at each save point used in the analysis, for 2020, 2040, and/or 2070.

3.1 No Action Alternative

In this section Figures 3-2 through 3-23 show the maximum water surface elevation and wave height throughout the basin for each modeled storm in 2020, 2040, and 2070 for the No Action Alternative.

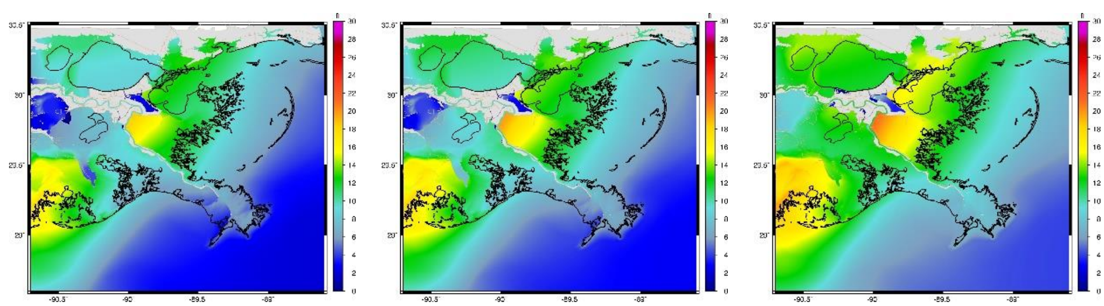


Figure 3-2. No Action Alternative maximum water surface elevation for storm 009, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

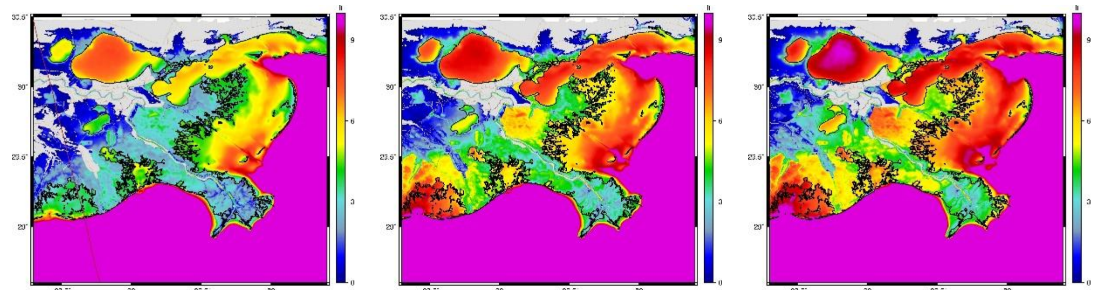


Figure 3-3. No Action Alternative maximum wave height for storm 009, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

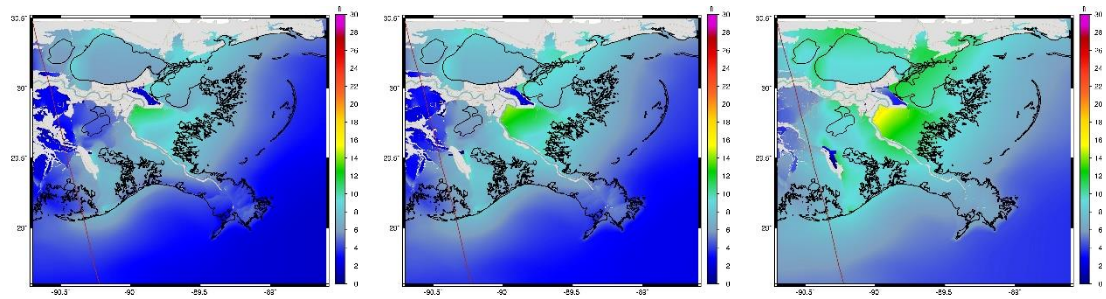


Figure 3-4. No Action Alternative maximum water surface elevation for storm 011, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

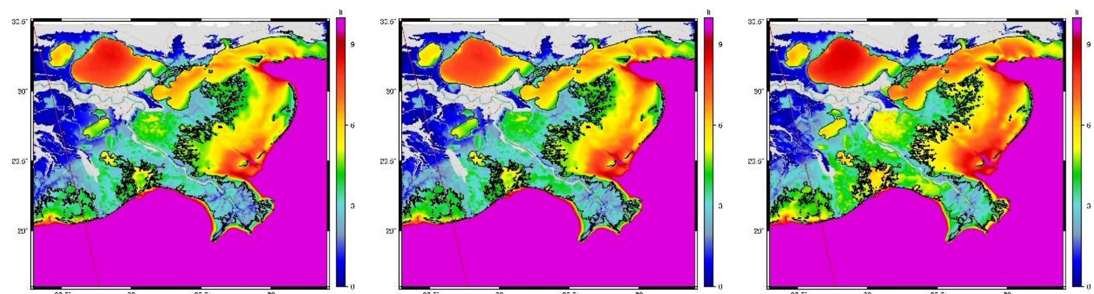


Figure 3-5. No Action Alternative maximum wave height for storm 011, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

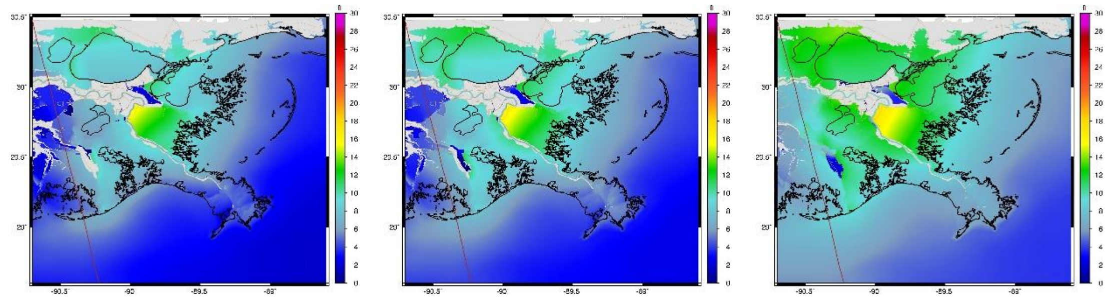


Figure 3-6. No Action Alternative maximum water surface elevation for storm 011 slow, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

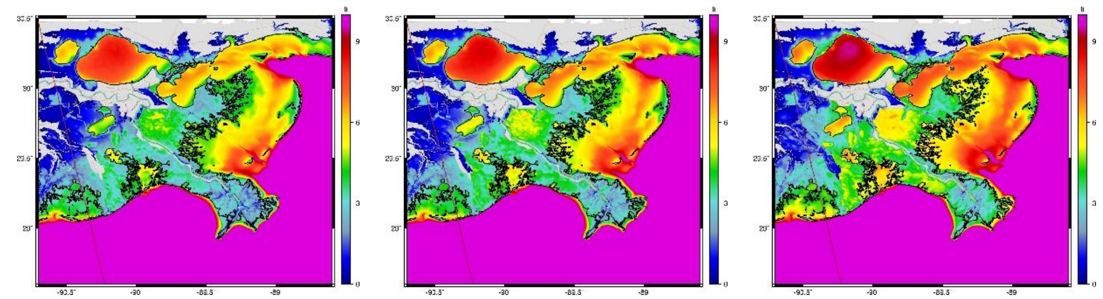


Figure 3-7. No Action Alternative maximum wave height for storm 011 slow, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

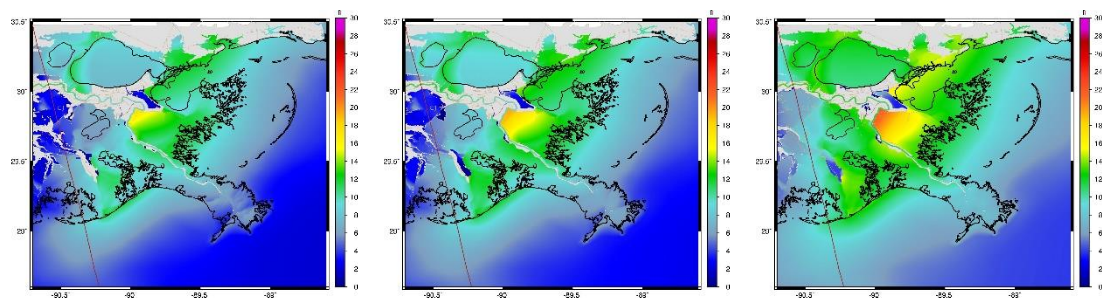


Figure 3-8. No Action Alternative maximum water surface elevation for storm 014, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

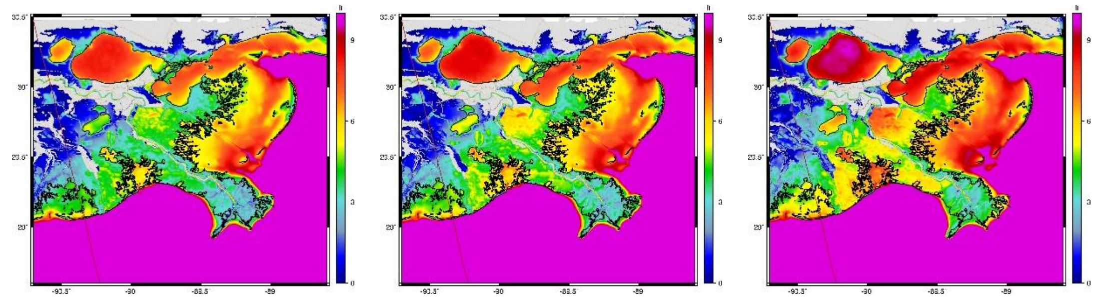


Figure 3-9. No Action Alternative maximum wave height for storm 014, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

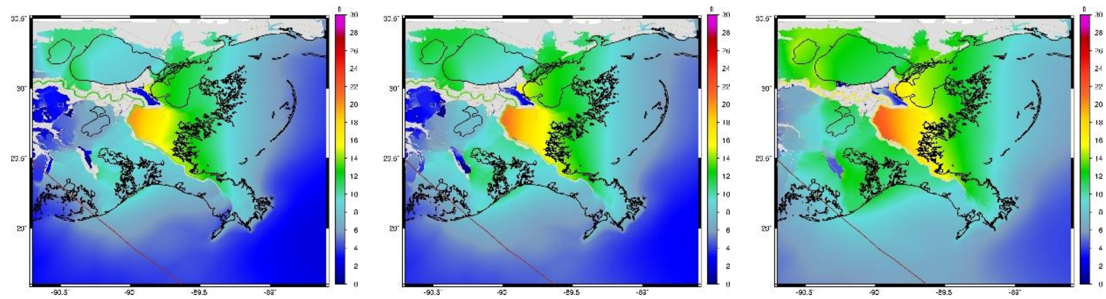


Figure 3-10. No Action Alternative maximum water surface elevation for storm 093, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

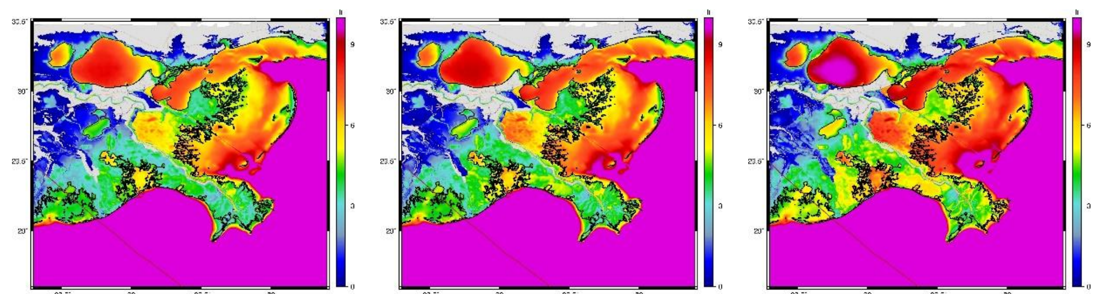


Figure 3-11. No Action Alternative maximum wave height for storm 093, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

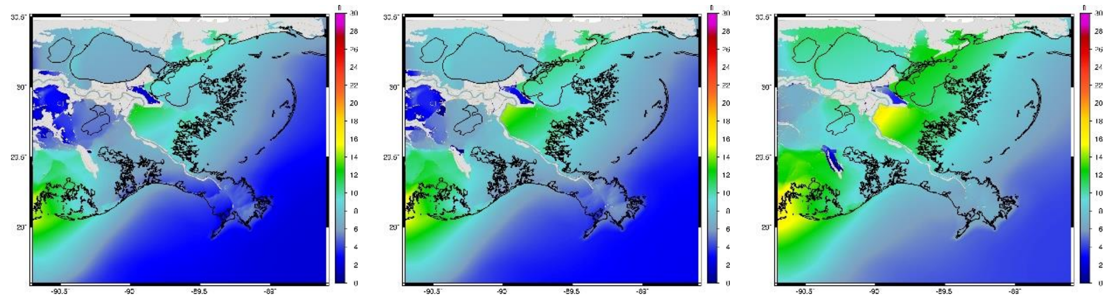


Figure 3-12. No Action Alternative maximum water surface elevation for storm 101, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

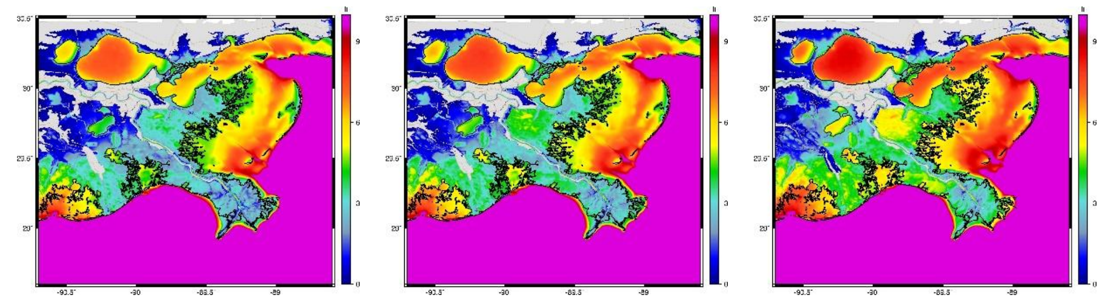


Figure 3-13. No Action Alternative maximum wave height for storm 101, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

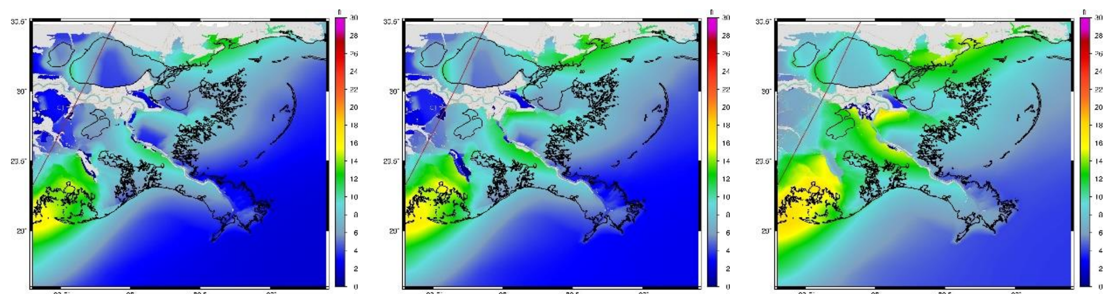


Figure 3-14. No Action Alternative maximum water surface elevation for storm 160, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

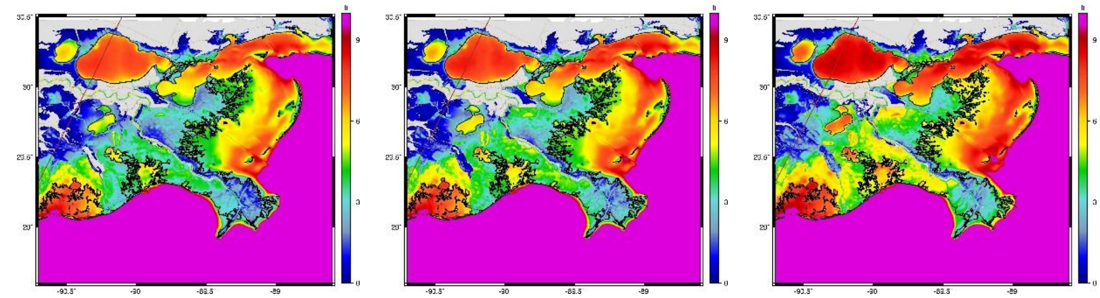


Figure 3-15. No Action Alternative maximum wave height for storm 160, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

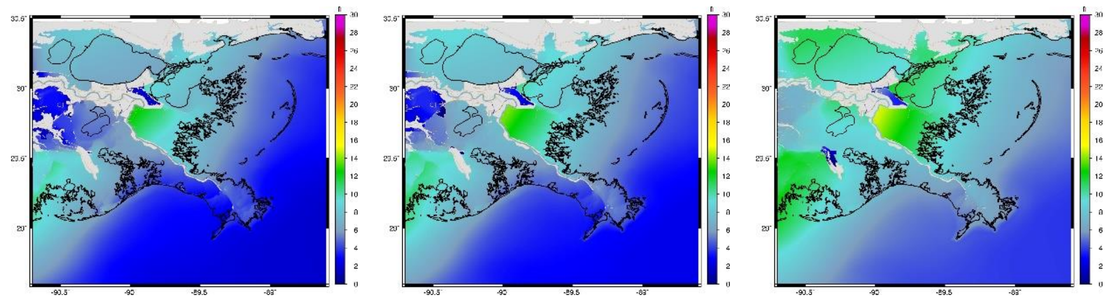


Figure 3-16. No Action Alternative maximum water surface elevation for storm 239, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

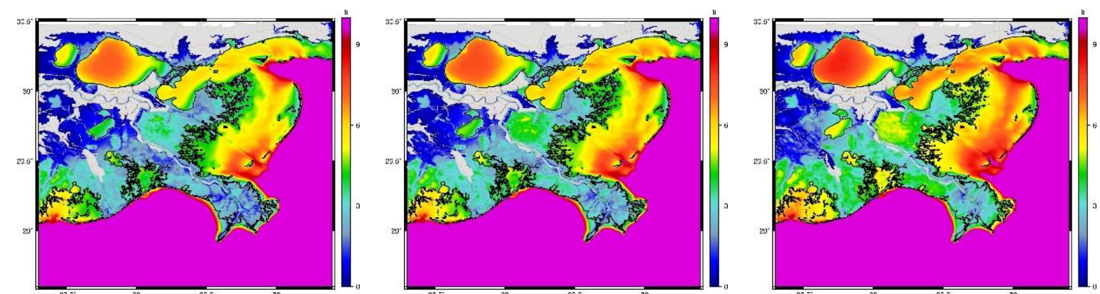


Figure 3-17. No Action Alternative maximum wave height for storm 239, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

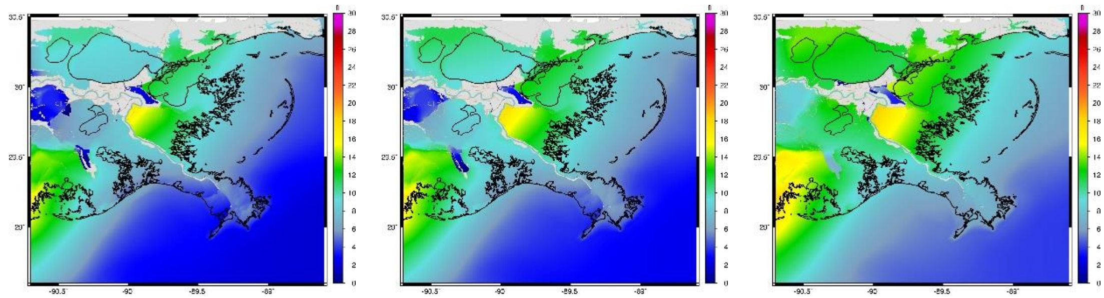


Figure 3-18. No Action Alternative maximum water surface elevation for storm 245, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

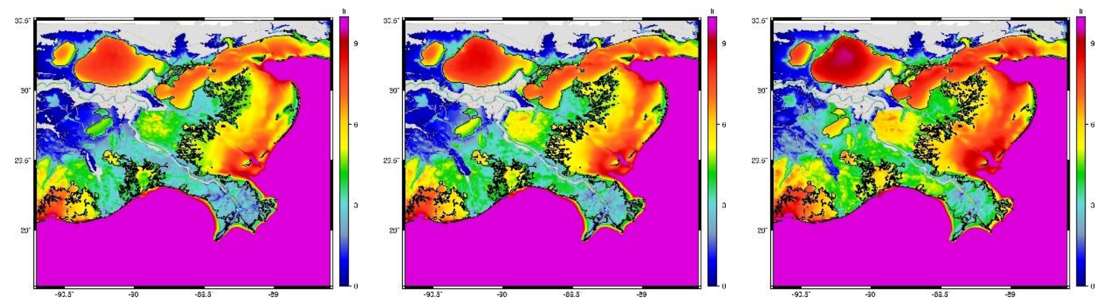


Figure 3-19. No Action Alternative maximum wave height for storm 245, 1 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

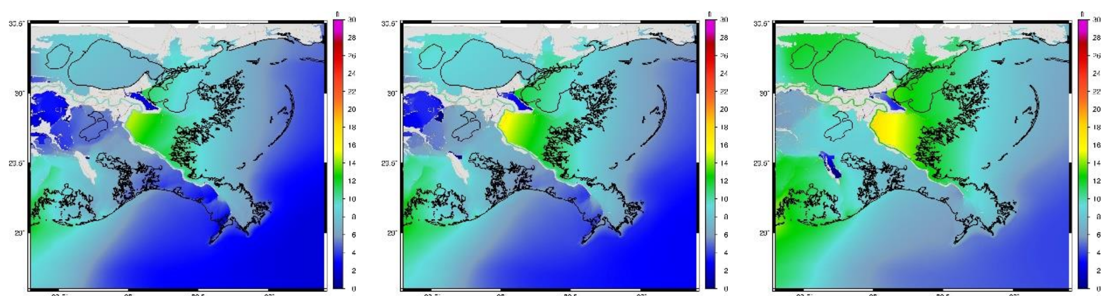


Figure 3-20. No Action Alternative maximum water surface elevation for storm 257, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

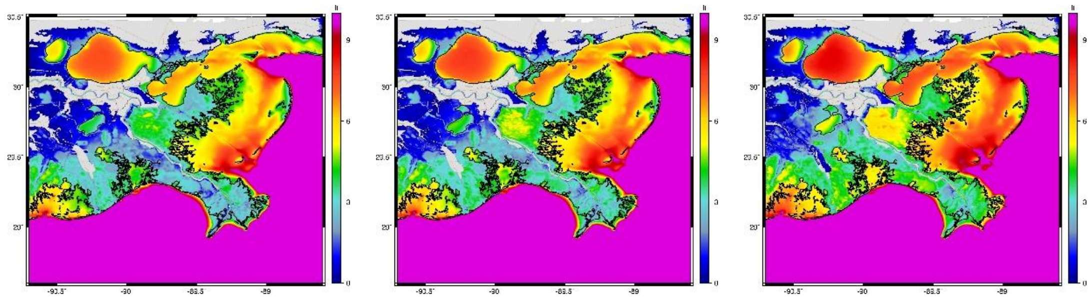


Figure 3-21. No Action Alternative maximum wave height for storm 257, 4 percent AEP storm, year 2020 (left), year 2040 (middle), year 2070 (right).

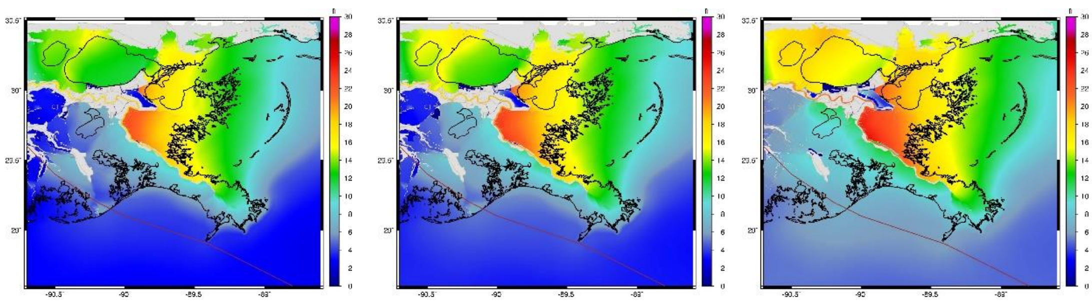


Figure 3-22. No Action Alternative maximum water surface elevation for storm Isaac, year 2020 (left), year 2040 (middle), year 2070 (right).

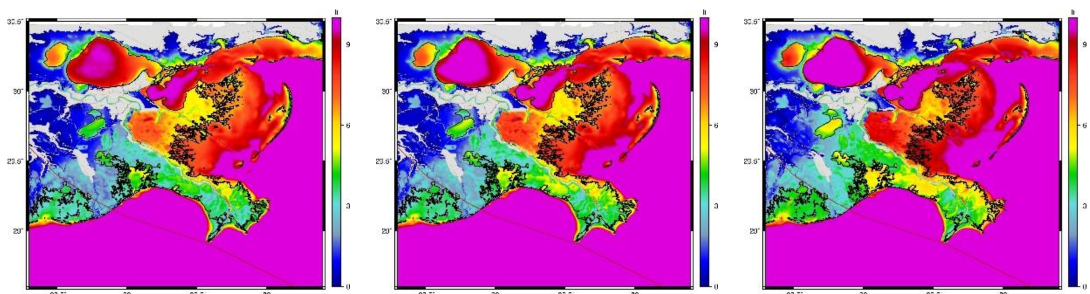


Figure 3-23. No Action Alternative maximum wave height for storm Isaac, year 2020 (left), year 2040 (middle), year 2070 (right).

Figures 3-24 through 3-39 show hydrographs that display the water surface elevation for a representative 1 percent AEP and 4 percent AEP simulated storm at each data extraction, or save point.

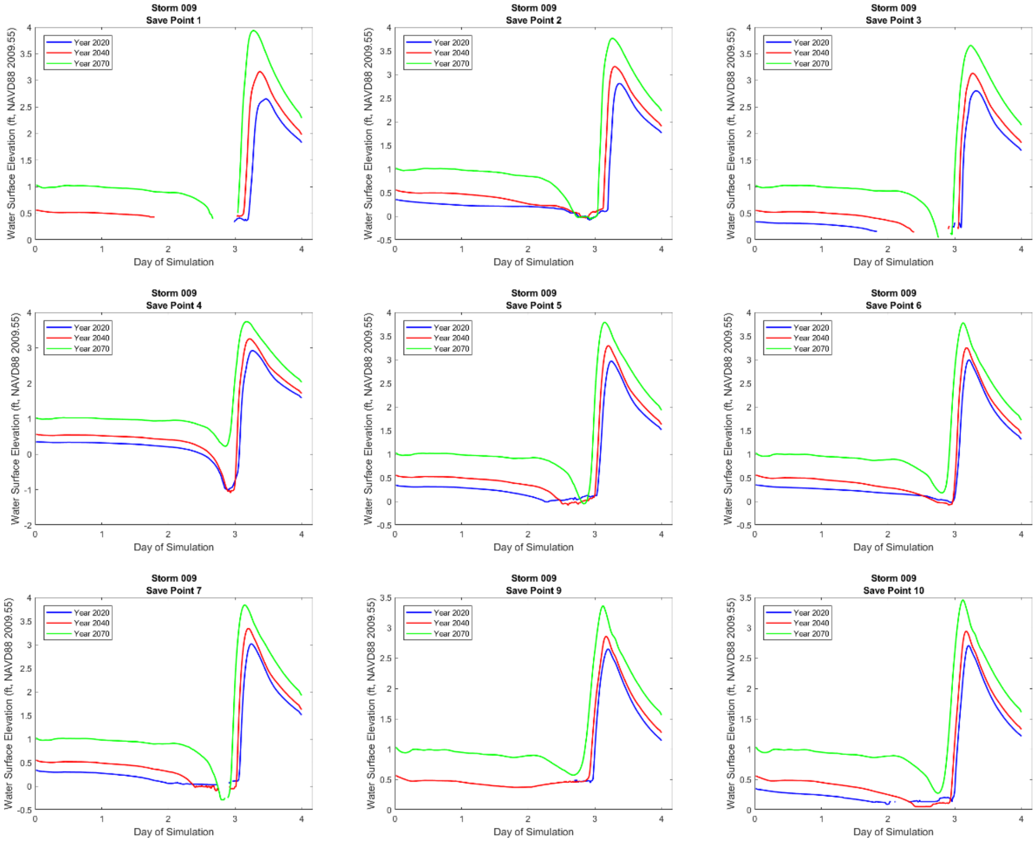


Figure 3-24. No Action Alternative Hydrographs at selected save points along the NOV-NFL for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

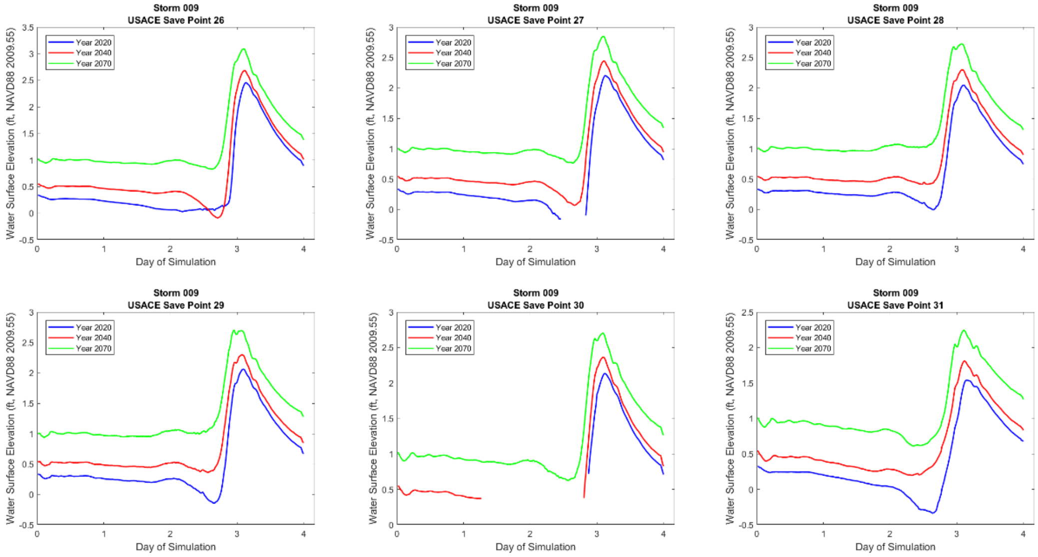


Figure 3-25. **No Action Alternative Hydrographs at selected save points along the NOV for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).**

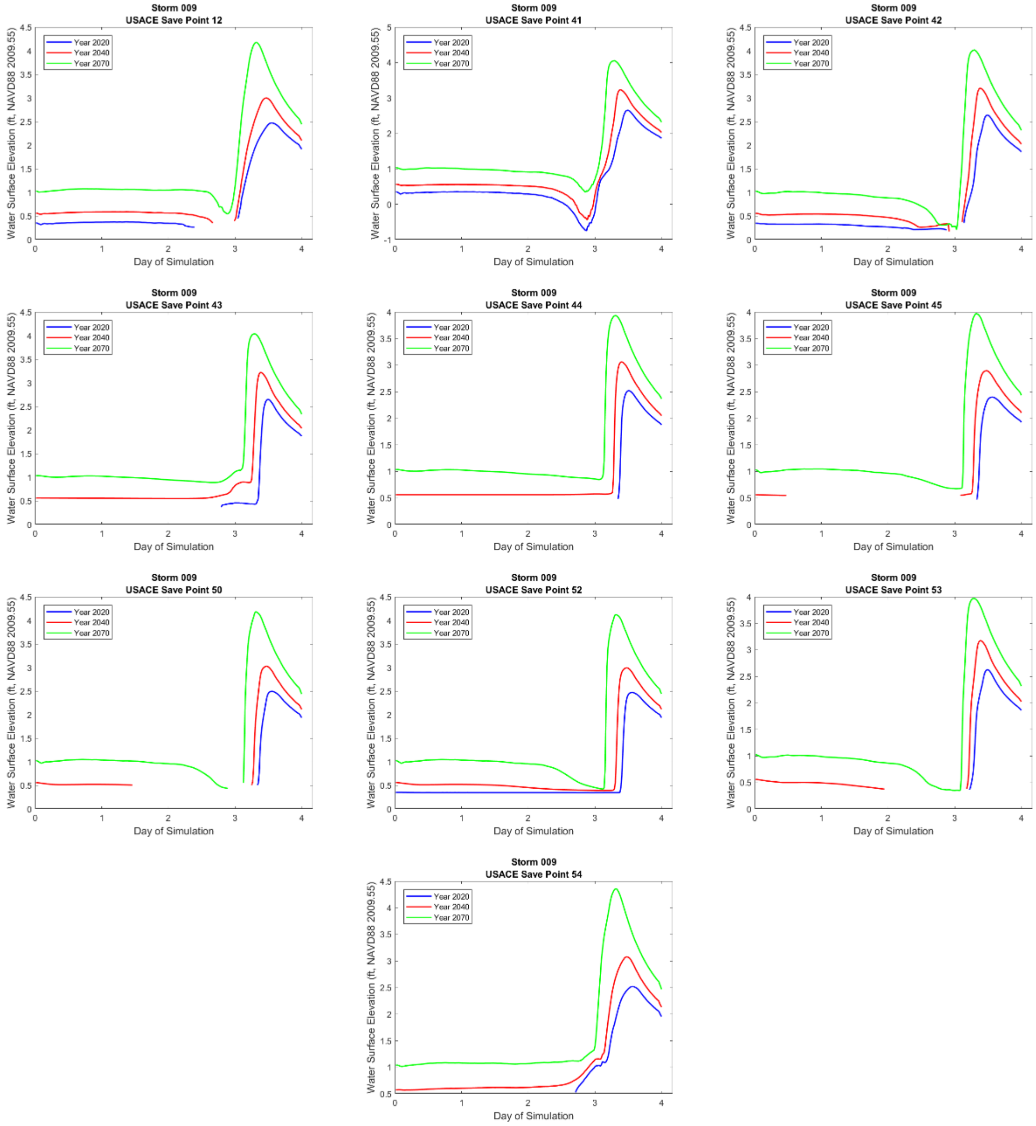


Figure 3-26. No Action Alternative Hydrographs at selected save points along the WBV for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

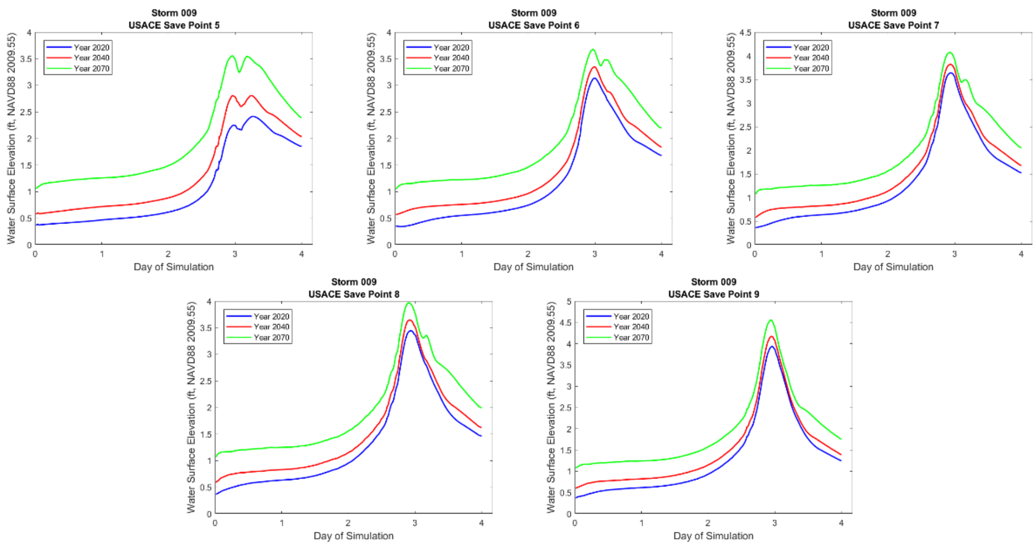


Figure 3-27. No Action Alternative Hydrographs at selected save points near the LGM for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

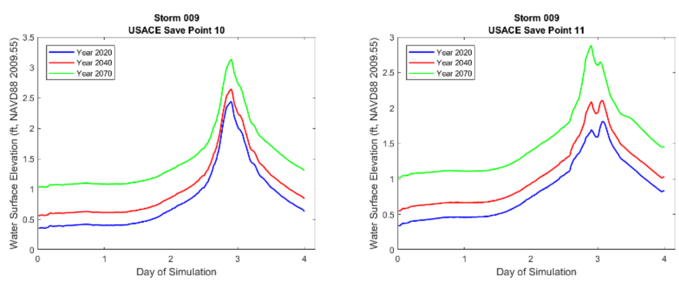


Figure 3-28. No Action Alternative Hydrographs at selected save points near Grand Isle for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

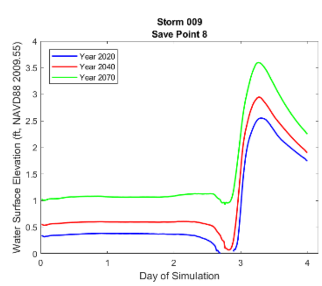


Figure 3-29. No Action Alternative Hydrographs at a save point near Lafitte for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

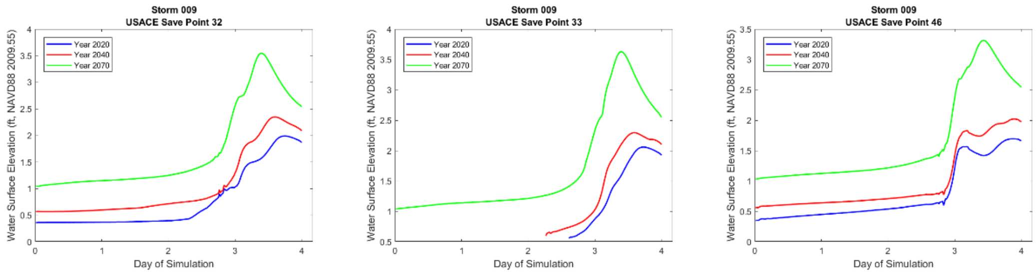


Figure 3-30. No Action Alternative Hydrographs at selected save points near Des Allemandes/ Bayou Grande for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

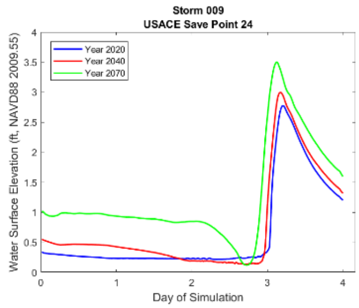


Figure 3-31. No Action Alternative Hydrographs at a save point near Grand Bayou for storm 009, 1 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

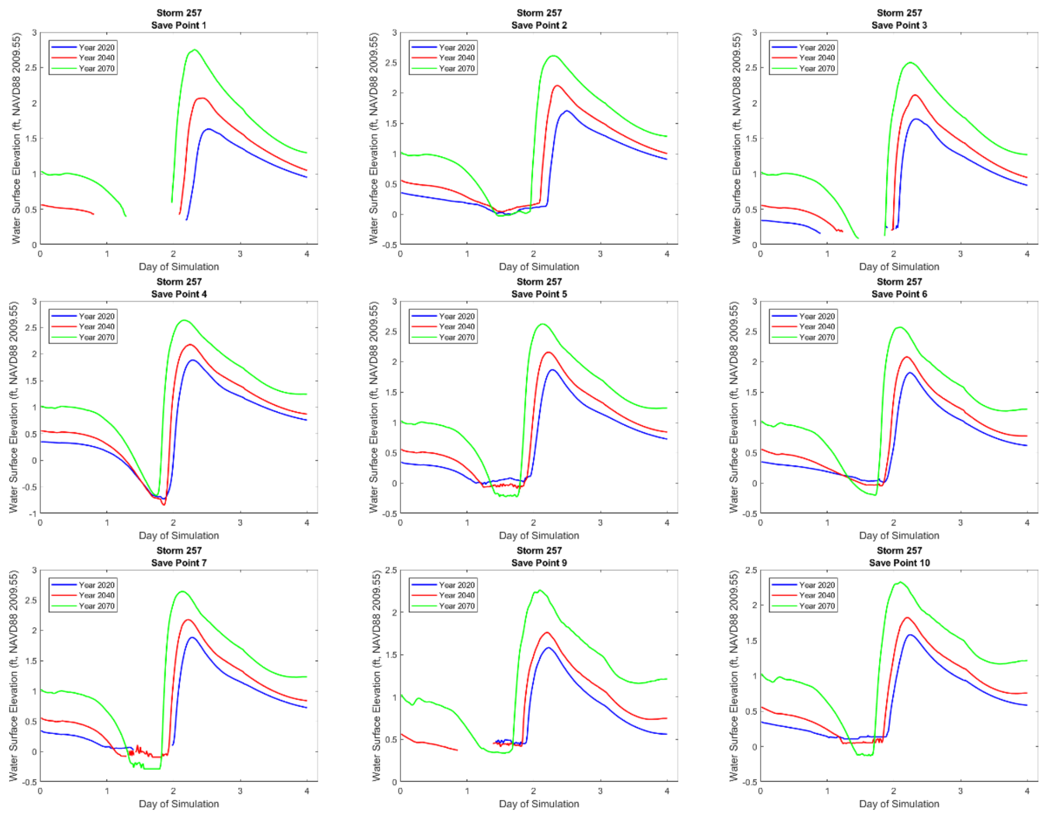


Figure 3-32. **No Action Alternative Hydrographs at selected save points along the NOV-NFL for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).**

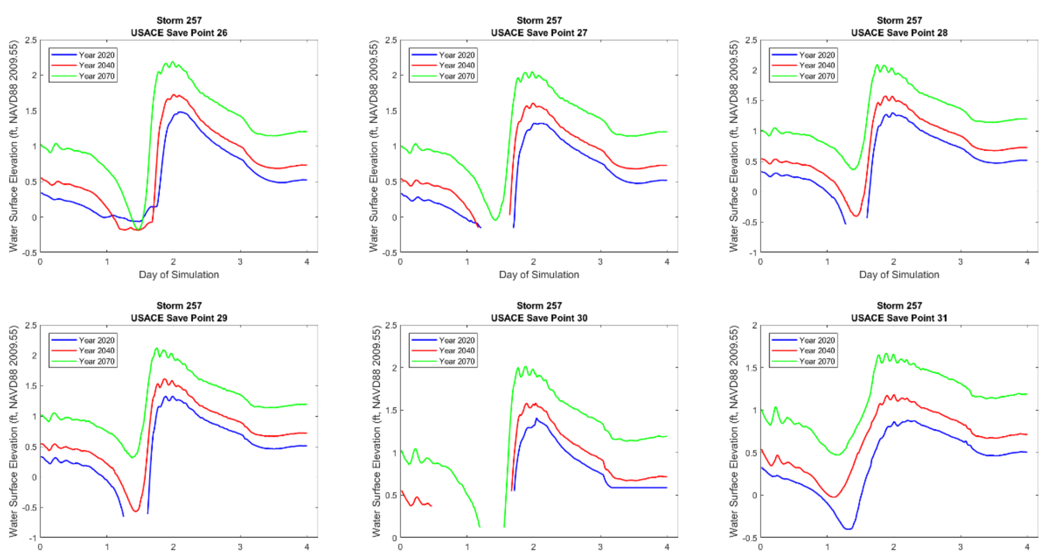


Figure 3-33. **No Action Alternative Hydrographs at selected save points along the NOV for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).**

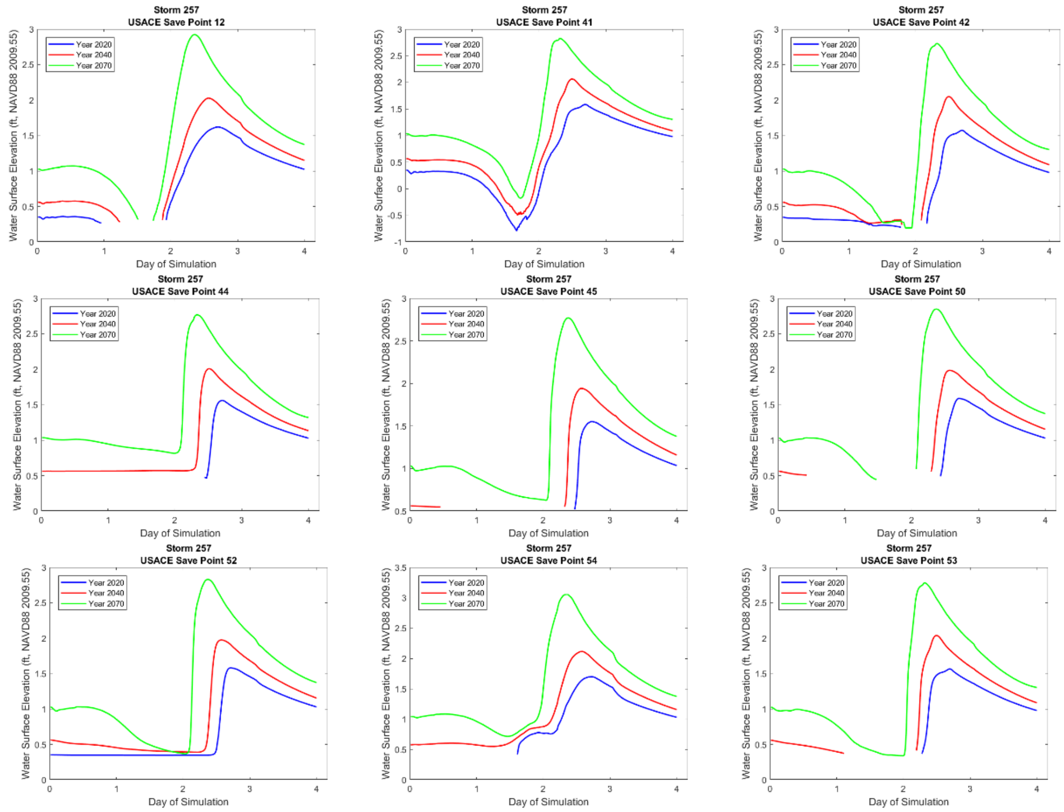


Figure 3-34. No Action Alternative Hydrographs at selected save points along the WBV for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

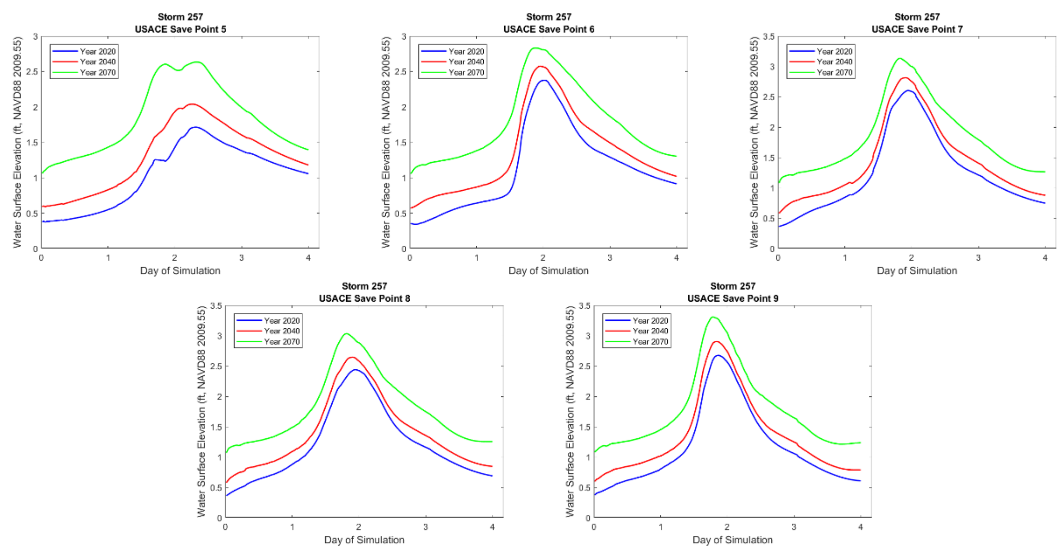


Figure 3-35. No Action Alternative Hydrographs at selected save points near the LGM for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

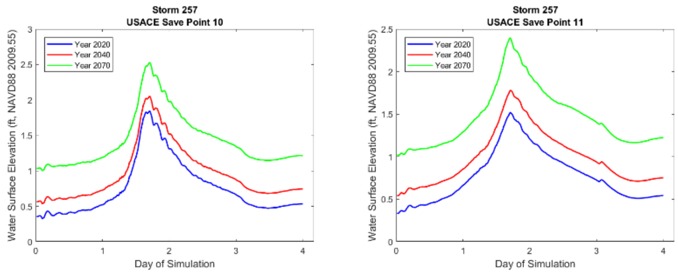


Figure 3-36. **No Action Alternative Hydrographs at selected save points near Grand Isle for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).**

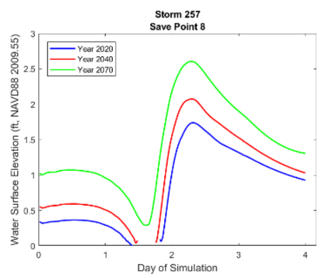


Figure 3-37. **No Action Alternative Hydrographs at a save point near Lafitte for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).**

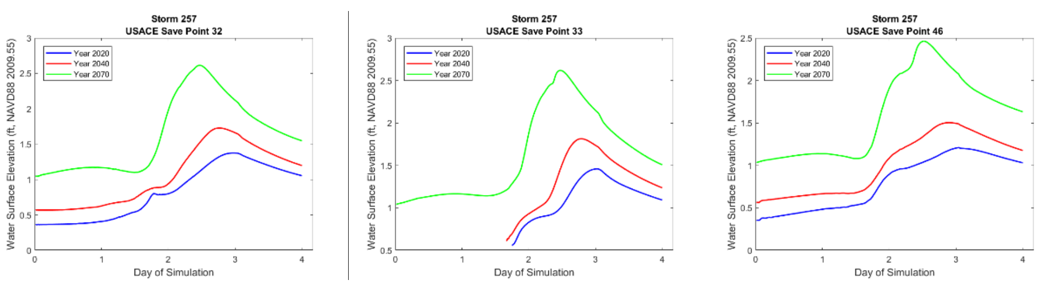


Figure 3-38. **No Action Alternative Hydrographs at selected save points near Des Allemandes/ Bayou Gauche for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).**

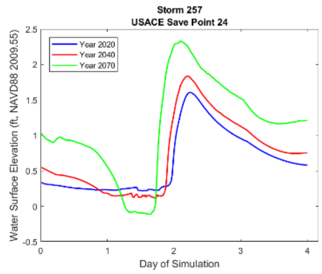


Figure 3-39. No Action Alternative Hydrographs at save point near Grand Bayou for storm 257, 4 percent AEP storm, showing water surface elevation for year 2020 (blue), year 2040 (red), year 2070 (green).

Tables 3-1 through 3-6 below list the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP simulated storms at each save point used in the analysis for 2020, 2040, and 2070.

Table 3-1
Projected Surge Elevation for No Action Alternative in 2020

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.1	9.7	7.9	4.9	6.6	5.9
	USACE 11	4.7	7.1	5.8	4.0	5.3	4.7
WBV	USACE 54	6.5	8.3	7.3	5.2	7.9	6.2
	USACE 12	6.6	8.1	7.2	5.1	7.8	6.0
	USACE 50	7.1	8.2	7.6	5.2	8.2	6.1
	USACE 52	7.0	8.1	7.5	5.2	8.0	6.1
	USACE 45	6.8	7.9	7.3	5.1	7.7	5.9
	USACE 44	7.6	8.3	7.9	5.1	8.2	6.2
	USACE 43	8.1	8.7	8.3	5.2	8.8	6.5
	USACE 41	8.1	8.7	8.3	5.2	8.8	6.5
	USACE 42	8.0	8.7	8.3	5.2	8.8	6.5
	USACE 53	8.0	8.8	8.3	5.1	8.7	6.4
LGM	USACE 5	5.7	7.9	6.8	4.7	7.4	5.6
	USACE 6	9.1	10.3	9.5	5.2	8.9	7.5
	USACE 7	10.2	11.9	10.8	5.4	10.6	8.5
	USACE 8	8.8	11.3	10.0	5.4	9.9	7.9
	USACE 9	9.7	12.9	11.1	5.0	10.0	8.2
Des Allemandes/ Bayou Gauche	USACE 46	3.9	5.6	4.7	3.2	4.7	3.9
	USACE 32	4.7	6.5	5.5	3.8	5.6	4.6
	USACE 33	5.1	6.8	5.9	4.1	6.3	5.1
Grand Bayou	USACE 24	8.0	11.4	9.7	5.3	9.4	7.3
NOV	USACE 26	7.0	10.1	8.7	4.9	10.0	6.9
	USACE 27	6.3	9.5	7.9	4.3	9.3	6.3
	USACE 28	5.8	8.4	7.4	4.2	8.9	5.8
	USACE 29	5.7	8.2	7.4	4.2	9.7	5.9
	USACE 30	6.1	8.5	7.6	4.6	10.4	6.3
	USACE 31	4.4	7.3	5.8	2.9	7.7	4.5
NOV-NFL	Arcadis 1	8.1	8.8	8.4	5.4	8.7	6.6
	Arcadis 2	8.4	9.7	9.0	5.6	9.0	6.9
	Arcadis 3	8.3	9.6	9.0	5.8	8.8	6.9
	Arcadis 4	8.6	10.0	9.5	6.2	9.1	7.3
	Arcadis 5	8.6	10.6	9.8	6.1	9.3	7.5
	Arcadis 6	8.6	11.2	10.1	6.0	9.4	7.7
	Arcadis 7	8.8	10.9	10.0	6.2	9.5	7.7
	Arcadis 9	7.6	10.8	9.2	5.2	9.1	7.0
	Arcadis 10	7.8	10.8	9.3	5.2	8.8	7.0
Lafitte	Arcadis 8	7.2	8.4	7.8	5.5	7.4	6.1

Table 3-2
Projected Surge Elevation for No Action Alternative in 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.8	10.3	8.5	5.6	7.2	6.5
	USACE 11	5.5	8.3	6.8	4.9	6.1	5.5
WBV	USACE 54	8.2	10.1	9.1	6.7	9.6	7.7
	USACE 12	8.5	9.8	8.9	6.6	9.4	7.5
	USACE 50	8.5	9.9	9.3	6.5	9.8	7.6
	USACE 52	8.4	9.8	9.2	6.5	9.7	7.5
	USACE 45	8.1	9.6	9.0	6.4	9.2	7.3
	USACE 44	9.1	10.4	9.7	6.6	9.9	7.8
	USACE 43	9.7	10.9	10.3	6.8	10.6	8.3
	USACE 41	9.7	11.0	10.3	6.8	10.6	8.2
	USACE 42	9.6	11.0	10.3	6.7	10.5	8.2
	USACE 53	9.6	11.0	10.2	6.7	10.4	8.1
LGM	USACE 5	7.2	9.2	8.2	5.6	8.8	6.9
	USACE 6	9.7	11.0	10.3	6.1	9.7	8.3
	USACE 7	10.8	12.5	11.6	6.4	11.3	9.3
	USACE 8	9.6	12.0	10.8	6.2	10.7	8.6
	USACE 9	10.7	13.7	12.0	6.1	10.8	9.1
Des Allemandes/ Bayou Gauche	USACE 46	4.9	6.6	5.7	4.2	5.7	4.9
	USACE 32	5.9	7.7	6.7	4.9	6.9	5.8
	USACE 33	6.4	7.5	6.9	5.4	7.2	6.2
Grand Bayou	USACE 24	8.7	12.3	10.4	6.0	9.9	8.0
NOV	USACE 26	7.6	10.8	9.5	5.7	10.7	7.6
	USACE 27	7.0	10.0	8.7	5.3	10.0	7.0
	USACE 28	6.5	9.1	8.2	5.1	9.5	6.6
	USACE 29	6.5	9.0	8.1	5.1	10.2	6.7
	USACE 30	6.7	9.1	8.3	5.2	10.9	7.0
	USACE 31	5.2	7.8	6.6	3.9	8.4	5.4
NOV-NFL	Arcadis 1	9.6	11.0	10.2	6.8	10.3	8.2
	Arcadis 2	9.5	11.4	10.4	7.0	10.2	8.3
	Arcadis 3	9.4	11.1	10.2	6.9	9.8	8.1
	Arcadis 4	9.6	11.5	10.7	7.1	10.1	8.4
	Arcadis 5	9.6	12.0	11.0	7.1	10.3	8.6
	Arcadis 6	9.4	12.3	11.0	6.8	10.2	8.5
	Arcadis 7	9.7	12.3	11.2	7.1	10.5	8.7
	Arcadis 9	8.3	11.7	9.9	5.8	9.5	7.7
	Arcadis 10	8.5	11.8	10.2	6.0	9.4	7.8
Lafitte	Arcadis 8	8.9	9.7	9.2	6.8	8.7	7.3

Table 3-3
Projected Surge Elevation for No Action Alternative in 2070

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	8.3	11.8	10.0	7.1	8.6	8.0
	USACE 11	7.5	10.8	9.1	6.6	7.9	7.4
WBV	USACE 54	12.1	14.3	13.0	10.0	13.3	11.2
	USACE 12	11.5	13.7	12.6	9.6	12.8	10.7
	USACE 50	11.3	15.0	13.1	9.3	13.1	10.8
	USACE 52	11.2	14.8	13.0	9.3	12.9	10.7
	USACE 45	10.8	14.2	12.5	9.1	12.3	10.3
	USACE 44	11.1	14.0	12.6	9.1	12.4	10.5
	USACE 43	11.7	14.5	13.1	9.3	13.0	10.9
	USACE 41	11.8	14.7	13.2	9.3	13.0	11.0
	USACE 42	11.6	14.7	13.1	9.2	12.9	10.9
	USACE 53	11.5	14.7	12.9	9.1	12.8	10.8
LGM	USACE 5	10.1	11.7	11.0	7.6	11.3	9.3
	USACE 6	10.5	12.2	11.5	7.7	10.9	9.4
	USACE 7	11.6	13.6	12.8	8.1	12.2	10.4
	USACE 8	11.0	13.4	12.3	7.9	11.9	10.0
	USACE 9	12.1	15.0	13.6	7.7	12.1	10.5
Des Allemandes/ Bayou Gauche	USACE 46	7.9	10.9	9.2	7.0	8.9	8.0
	USACE 32	8.9	11.6	10.0	7.7	9.6	8.6
	USACE 33	8.9	11.9	10.1	7.9	10.0	8.8
Grand Bayou	USACE 24	10.1	14.1	12.1	7.7	11.3	9.7
NOV	USACE 26	8.9	12.1	10.8	7.2	11.7	8.9
	USACE 27	8.3	11.3	10.0	6.7	10.9	8.3
	USACE 28	7.9	10.5	9.6	6.6	10.7	8.1
	USACE 29	7.8	10.5	9.5	6.6	11.2	8.1
	USACE 30	7.9	10.4	9.5	6.5	11.6	8.1
	USACE 31	6.7	9.0	8.0	5.5	9.6	6.8
NOV-NFL	Arcadis 1	11.4	14.4	12.8	9.0	12.5	10.6
	Arcadis 2	10.8	14.3	12.3	8.6	11.9	10.1
	Arcadis 3	10.8	13.7	12.0	8.4	11.4	9.8
	Arcadis 4	11.1	14.1	12.5	8.7	11.6	10.1
	Arcadis 5	11.1	14.5	12.8	8.6	11.8	10.2
	Arcadis 6	10.9	14.6	12.9	8.4	11.7	10.3
	Arcadis 7	11.2	14.9	13.0	8.7	12.0	10.4
	Arcadis 9	9.7	13.4	11.6	7.4	10.9	9.3
	Arcadis 10	9.9	13.7	11.9	7.6	10.9	9.5
Lafitte	Arcadis 8	10.4	11.9	11.2	8.6	10.7	9.3

Table 3-4 Projected Wave Height for No Action Alternative in 2020							
Levee System/ Community	**Save Point**	**1% AEP Storms**			**4% AEP Storms**		
		Min (ft)	**Max (ft)**	**Mean (ft)**	**Min (ft)**	**Max (ft)**	**Mean (ft)**
Grand Isle	USACE 10	5.1	7.0	6.1	4.7	5.9	5.4
	USACE 11	3.0	4.0	3.5	2.6	3.4	3.0
WBV	USACE 54	1.0	1.4	1.2	0.6	1.1	0.8
	USACE 12	1.9	2.3	2.1	1.2	2.4	1.6
	USACE 50	0.4	0.7	0.6	0.2	0.6	0.4
	USACE 52	0.3	0.5	0.4	0.0	1.2	0.4
	USACE 45	0.2	0.6	0.3	0.1	0.4	0.2
	USACE 44	0.3	0.4	0.4	0.2	0.4	0.3
	USACE 43	0.7	0.8	0.7	0.4	0.9	0.6
	USACE 41	0.9	2.0	1.2	0.6	1.2	0.9
	USACE 42	1.3	1.7	1.4	0.7	1.7	1.1
	USACE 53	0.3	0.8	0.5	0.1	0.6	0.3
LGM	USACE 5	2.6	3.4	3.2	1.9	3.0	2.4
	USACE 6	3.0	3.7	3.3	1.1	3.1	2.4
	USACE 7	3.2	4.2	3.7	1.5	3.7	2.7
	USACE 8	3.3	4.2	3.7	2.0	3.7	2.9
	USACE 9	3.8	4.9	4.2	1.5	3.8	3.0
Des Allemandes/ Bayou Gauche	USACE 46	2.0	2.4	2.1	1.4	2.0	1.6
	USACE 32	0.9	1.4	1.2	0.7	1.1	0.9
	USACE 33	0.2	0.4	0.3	0.2	0.4	0.3
Grand Bayou	USACE 24	2.4	3.8	3.1	1.2	2.9	2.0
NOV	USACE 26	2.7	3.9	3.4	1.9	3.9	2.6
	USACE 27	1.9	3.4	2.5	1.1	3.0	1.9
	USACE 28	2.4	3.6	3.1	1.7	3.7	2.4
	USACE 29	2.8	3.8	3.4	2.1	4.2	2.8
	USACE 30	1.5	2.4	2.1	0.9	3.2	1.6
	USACE 31	1.6	3.0	2.3	1.1	2.9	1.7
NOV-NFL	Arcadis 1	1.5	1.9	1.7	0.8	1.9	1.2
	Arcadis 2	2.1	3.0	2.5	1.0	2.6	1.7
	Arcadis 3	2.3	3.1	2.7	1.5	2.7	2.0
	Arcadis 4	3.6	4.4	4.0	2.7	4.0	3.2
	Arcadis 5	3.0	3.9	3.5	2.0	3.4	2.6
	Arcadis 6	3.5	4.7	4.1	2.4	4.0	3.1
	Arcadis 7	2.8	3.8	3.4	1.8	3.3	2.4
	Arcadis 9	1.9	3.1	2.6	1.0	2.6	1.7
	Arcadis 10	2.4	3.6	3.0	1.4	2.9	2.1
Lafitte	Arcadis 8	2.6	2.9	2.8	1.8	2.7	2.1

Table 3-5
Projected Wave Height for No Action Alternative in 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	5.5	7.3	6.5	5.2	6.2	5.7
	USACE 11	3.3	4.5	3.9	2.9	3.8	3.4
WBV	USACE 54	1.0	1.6	1.4	0.8	1.3	1.1
	USACE 12	2.4	2.9	2.7	1.5	3.0	2.1
	USACE 50	0.5	1.0	0.7	0.3	0.9	0.5
	USACE 52	0.2	0.8	0.5	0.1	0.6	0.3
	USACE 45	0.1	0.8	0.4	0.1	1.0	0.4
	USACE 44	0.5	1.0	0.8	0.7	1.0	0.8
	USACE 43	1.0	1.1	1.0	0.6	1.1	0.8
	USACE 41	0.9	2.1	1.3	0.6	1.3	1.0
	USACE 42	1.7	2.4	2.1	0.9	2.4	1.5
	USACE 53	0.4	1.2	0.7	0.1	0.8	0.4
LGM	USACE 5	3.0	3.8	3.5	2.1	3.3	2.6
	USACE 6	3.3	4.0	3.7	1.4	3.5	2.7
	USACE 7	3.6	4.5	4.1	1.9	4.0	3.1
	USACE 8	3.5	4.5	4.1	2.2	4.0	3.1
	USACE 9	4.1	5.2	4.6	1.9	4.1	3.3
Des Allemandes/ Bayou Gauche	USACE 46	2.1	2.6	2.2	1.4	2.1	1.7
	USACE 32	1.1	1.8	1.6	0.9	1.5	1.2
	USACE 33	0.3	0.5	0.4	0.2	0.5	0.4
Grand Bayou	USACE 24	2.9	4.4	3.6	2.0	3.3	2.7
NOV	USACE 26	3.1	4.4	3.9	2.3	4.3	3.1
	USACE 27	2.1	3.6	2.8	1.3	3.2	2.1
	USACE 28	2.9	4.1	3.6	2.2	4.1	2.9
	USACE 29	3.2	4.2	3.9	2.5	4.6	3.3
	USACE 30	1.8	2.7	2.4	1.2	3.4	1.9
	USACE 31	2.0	3.3	2.6	1.3	3.3	2.0
NOV-NFL	Arcadis 1	2.1	2.7	2.3	1.2	2.4	1.7
	Arcadis 2	2.7	4.0	3.2	1.4	3.3	2.3
	Arcadis 3	2.8	3.7	3.3	1.8	3.2	2.4
	Arcadis 4	4.1	5.0	4.6	3.1	4.4	3.7
	Arcadis 5	3.6	4.6	4.1	2.6	3.9	3.2
	Arcadis 6	3.9	5.3	4.6	2.9	4.4	3.6
	Arcadis 7	3.4	4.5	4.0	2.4	3.8	3.1
	Arcadis 9	2.1	3.2	2.7	1.4	2.6	1.9
	Arcadis 10	3.0	4.2	3.6	2.1	3.3	2.7
Lafitte	Arcadis 8	3.2	3.6	3.4	2.3	3.3	2.6

Table 3-6
Projected Wave Height for No Action Alternative in 2070

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.6	7.9	7.3	6.1	6.8	6.4
	USACE 11	3.8	5.5	4.7	3.4	4.4	4.0
WBV	USACE 54	2.1	3.1	2.6	1.7	2.4	2.0
	USACE 12	3.7	4.5	4.2	2.7	4.3	3.4
	USACE 50	1.0	2.0	1.4	0.6	1.5	1.0
	USACE 52	0.5	1.5	0.9	0.2	0.9	0.6
	USACE 45	0.2	1.2	0.6	0.1	0.5	0.3
	USACE 44	0.7	0.9	0.9	0.5	0.9	0.7
	USACE 43	1.5	2.0	1.7	1.0	1.7	1.3
	USACE 41	1.1	2.3	1.5	0.8	1.5	1.2
	USACE 42	2.5	4.4	3.4	1.6	3.5	2.5
	USACE 53	0.6	2.3	1.2	0.3	1.2	0.8
LGM	USACE 5	3.5	4.5	4.0	2.6	3.5	3.1
	USACE 6	3.9	4.6	4.4	2.4	4.2	3.4
	USACE 7	4.1	5.0	4.7	2.7	4.6	3.7
	USACE 8	4.0	5.2	4.7	2.8	4.6	3.7
	USACE 9	4.7	5.9	5.4	2.6	4.8	4.0
Des Allemandes/ Bayou Gauche	USACE 46	2.2	2.8	2.4	1.6	2.3	1.9
	USACE 32	2.5	3.3	2.9	2.1	2.9	2.5
	USACE 33	0.6	1.3	1.0	0.6	0.8	0.8
Grand Bayou	USACE 24	3.7	5.3	4.5	2.8	4.1	3.5
NOV	USACE 26	3.8	5.2	4.6	3.0	5.0	3.8
	USACE 27	2.6	4.0	3.3	1.9	3.6	2.6
	USACE 28	3.8	5.0	4.5	3.1	5.1	3.8
	USACE 29	4.0	5.1	4.7	3.4	5.3	4.1
	USACE 30	2.5	3.5	3.1	1.9	3.9	2.6
	USACE 31	1.9	2.9	2.5	1.4	3.0	1.9
NOV-NFL	Arcadis 1	3.5	4.8	4.0	2.5	4.0	3.2
	Arcadis 2	3.3	5.1	4.0	2.3	4.0	3.1
	Arcadis 3	3.5	4.9	4.1	2.5	3.9	3.1
	Arcadis 4	4.8	6.1	5.4	3.8	5.1	4.4
	Arcadis 5	4.2	5.7	4.9	3.3	4.6	3.9
	Arcadis 6	4.7	6.3	5.5	3.6	5.0	4.4
	Arcadis 7	4.1	5.7	4.9	3.1	4.5	3.8
	Arcadis 9	3.2	4.6	3.9	2.4	3.7	3.0
	Arcadis 10	3.8	5.2	4.5	2.9	4.1	3.6
Lafitte	Arcadis 8	3.9	4.7	4.2	3.0	4.1	3.4

3.2 Applicant's Preferred Alternative

In this section, Figures 3-40 through 3-61 show the maximum water surface elevation and wave height throughout the basin for each modeled storm in 2040 and 2070 for the Applicant's Preferred Alternative.

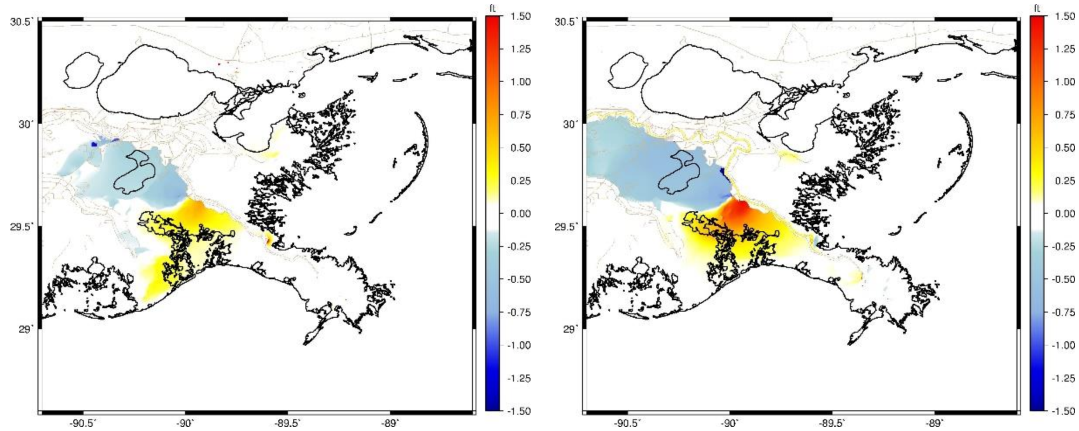


Figure 3-40. Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 009, 1 percent AEP storm, year 2040 (left), year 2070 (right).

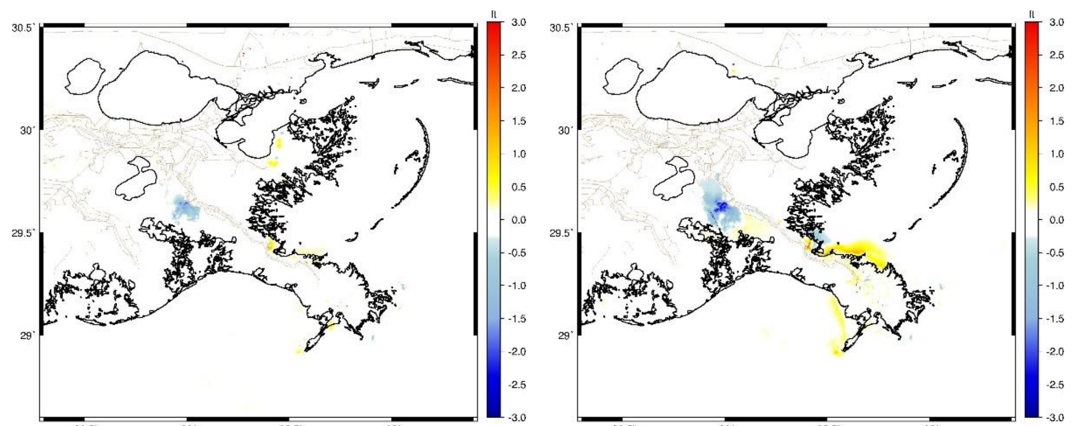


Figure 3-41. Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 009, 1 percent AEP storm, year 2040 (left), year 2070 (right).

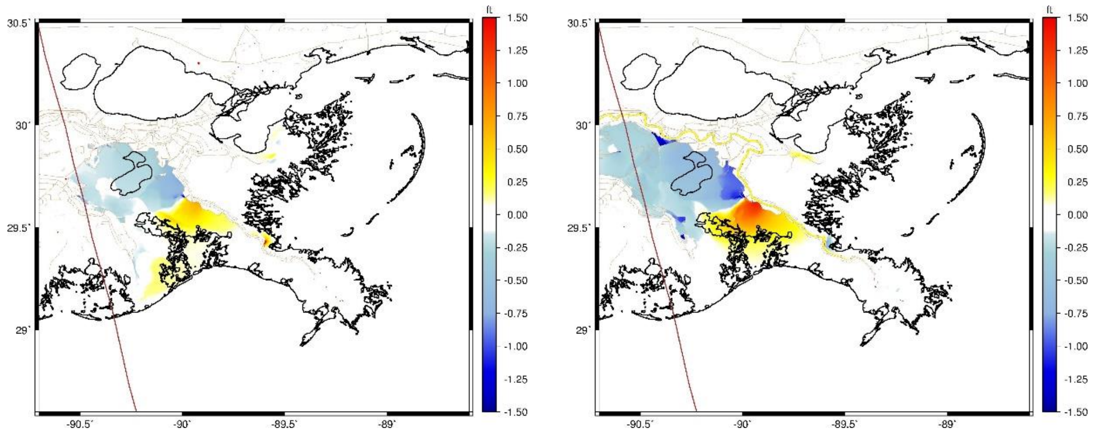


Figure 3-42. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 011, 4 percent AEP storm, year 2040 (left), year 2070 (right).**

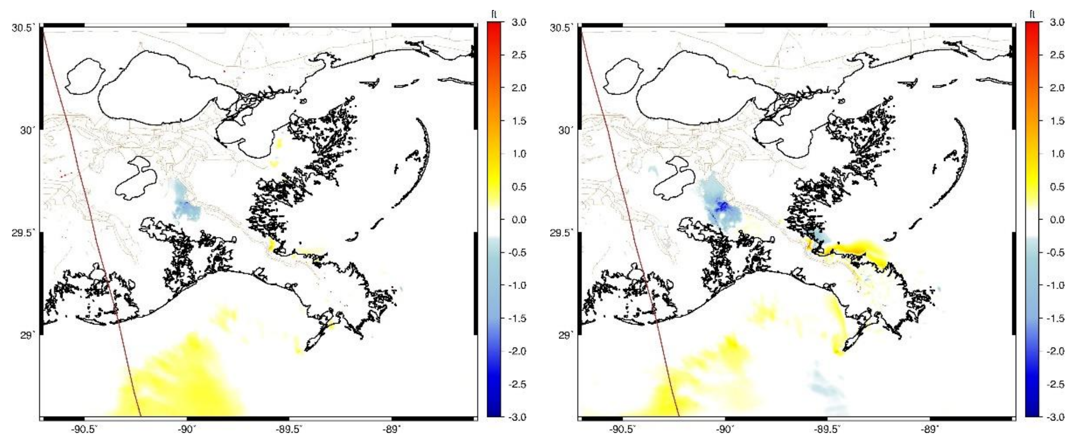


Figure 3-43. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 011, 4 percent AEP storm, year 2040 (left), year 2070 (right).**

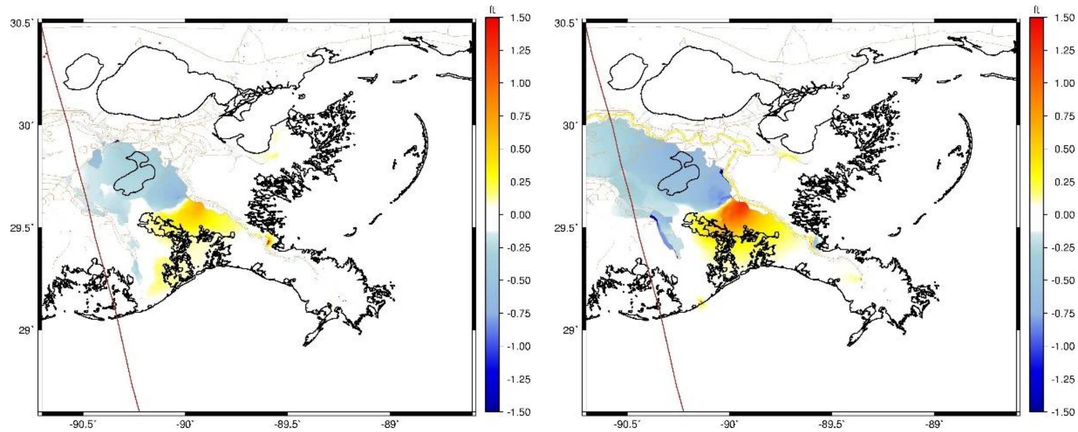


Figure 3-44. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 011 slow, 4 percent AEP storm, year 2040 (left), year 2070 (right).**

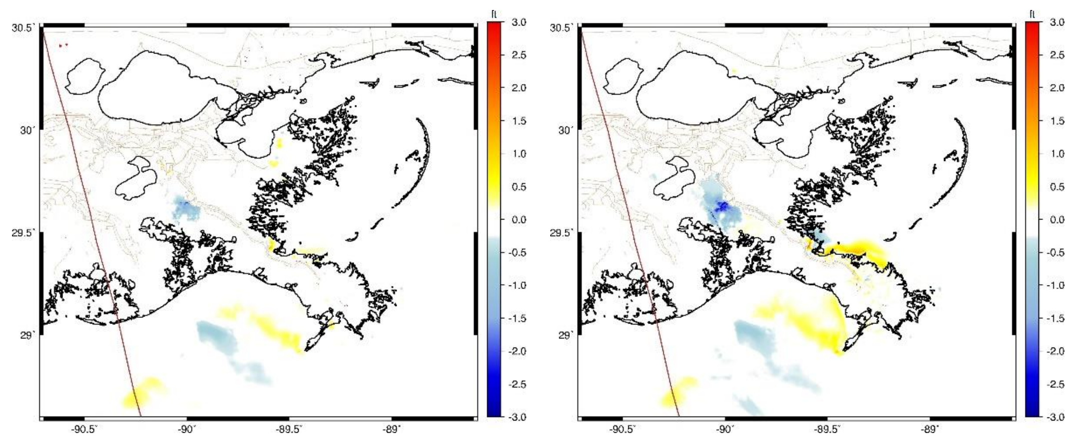


Figure 3-45. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 011 slow, 4 percent AEP storm, year 2040 (left), year 2070 (right).**

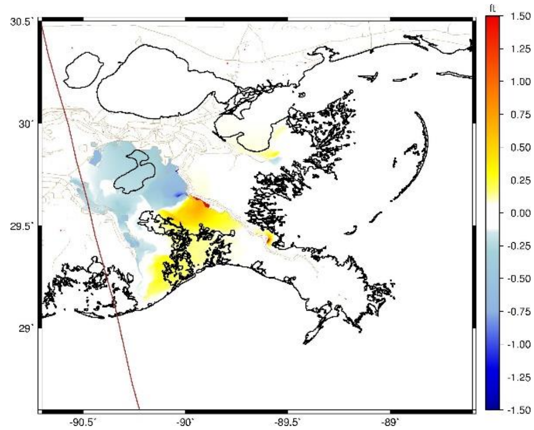


Figure 3-46. Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 014, 1 percent AEP storm, year 2040 (left), year 2070 (right).

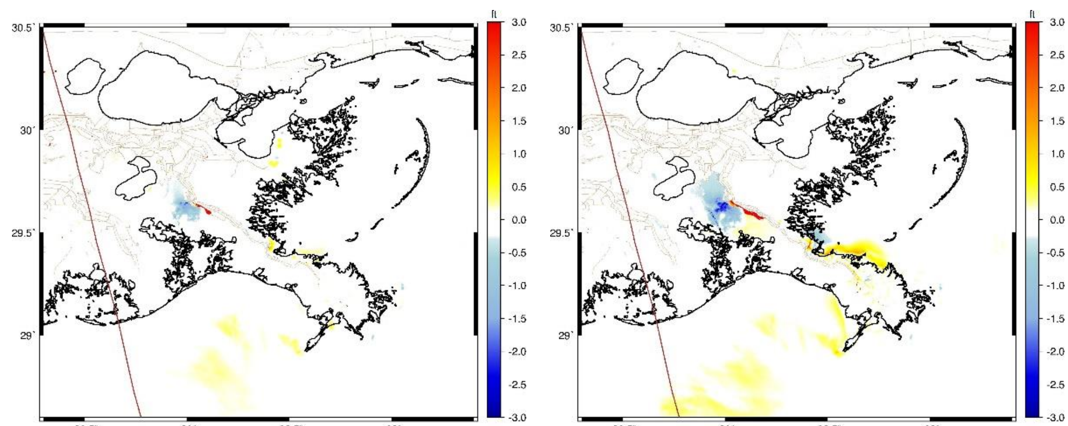


Figure 3-47. Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 014, 1 percent AEP storm, year 2040 (left), year 2070 (right).

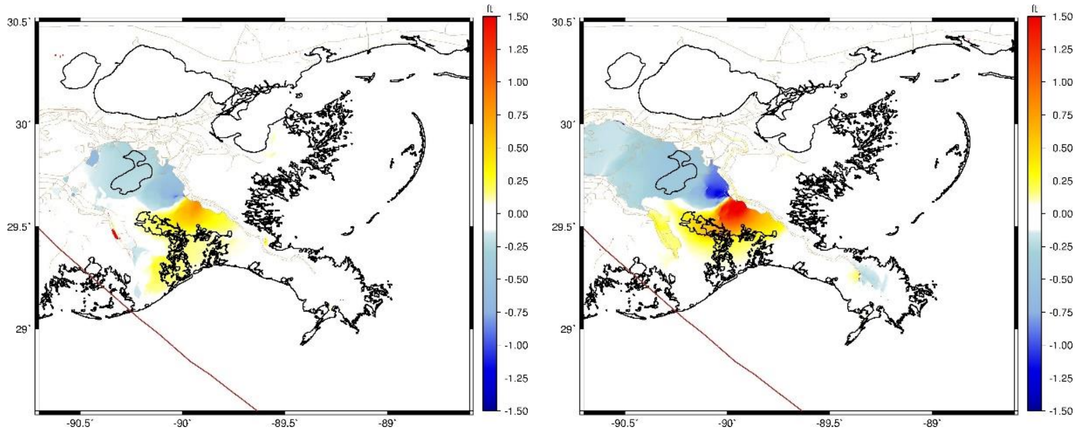


Figure 3-48. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 093, 1 percent AEP storm, year 2040 (left), year 2070 (right).**

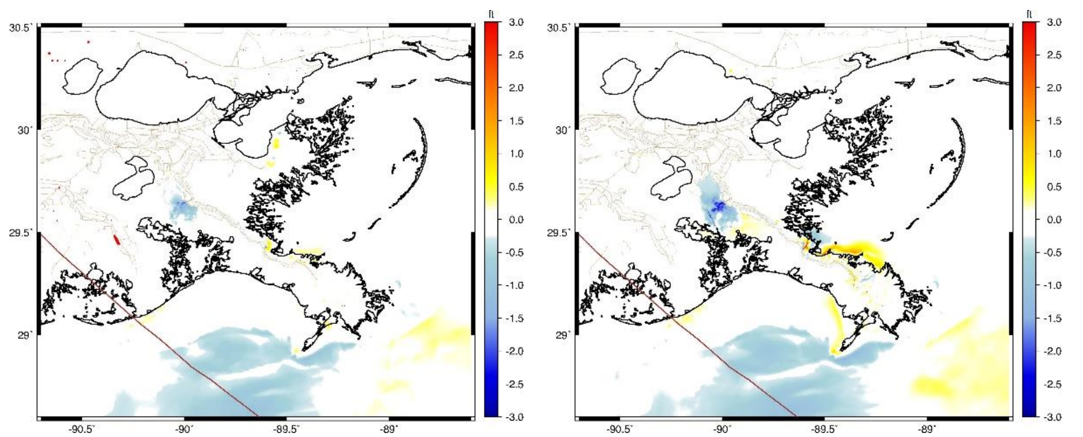


Figure 3-49. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 093, 1 percent AEP storm, year 2040 (left), year 2070 (right).**

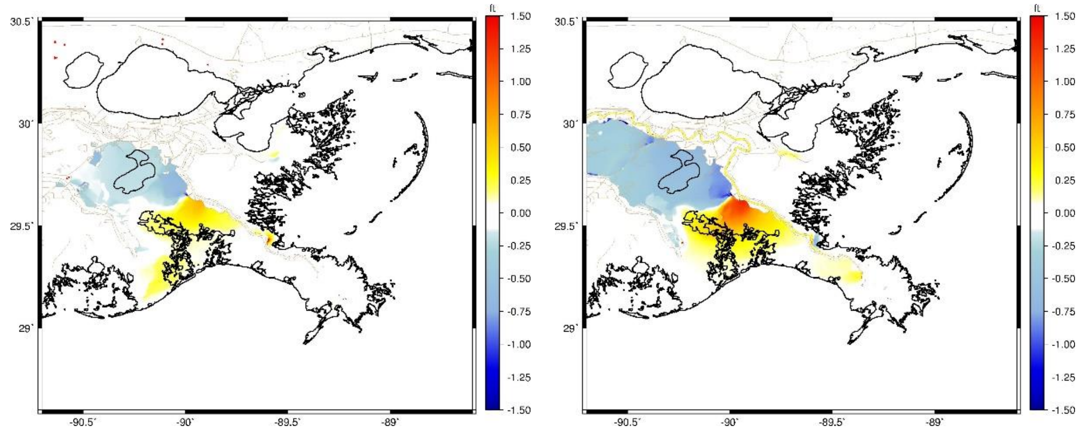


Figure 3-50. Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 101, 4 percent AEP storm, year 2040 (left), year 2070 (right).

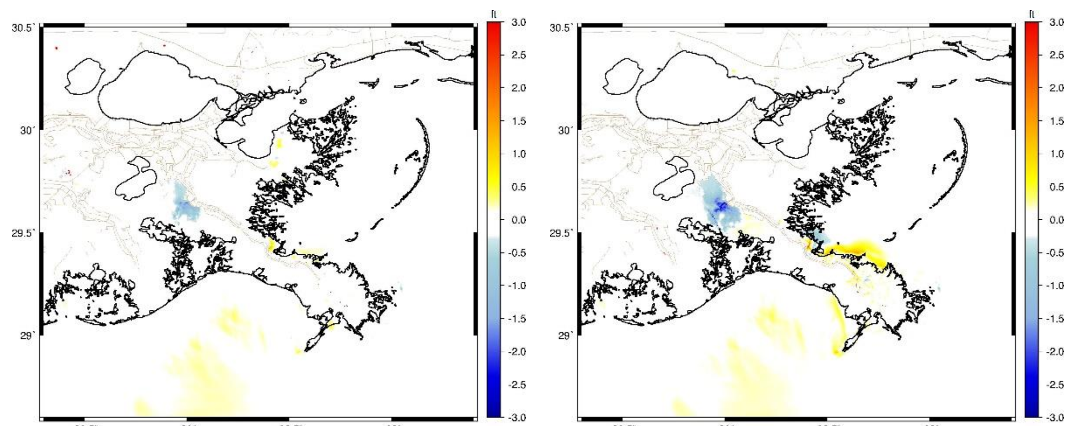


Figure 3-51. Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 101, 4 percent AEP storm, year 2040 (left), year 2070 (right).

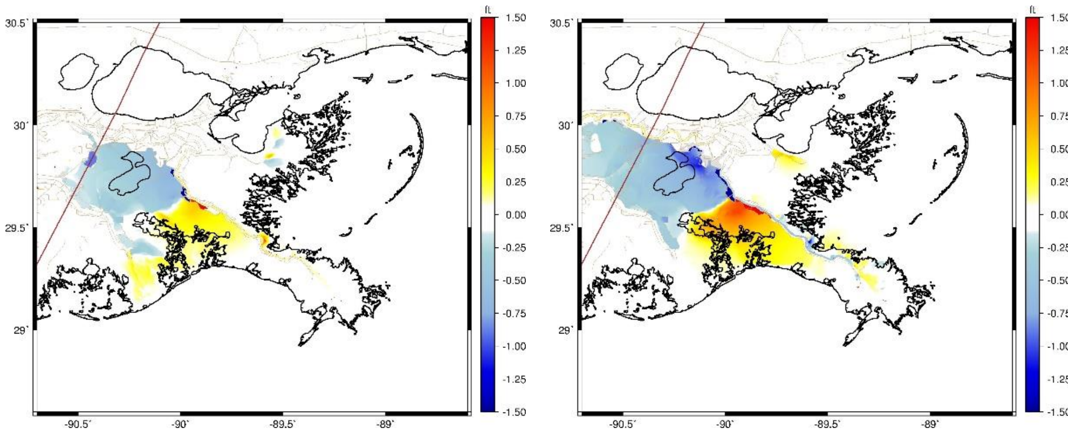


Figure 3-52. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 160, 1 percent AEP storm, year 2040 (left), year 2070 (right).**

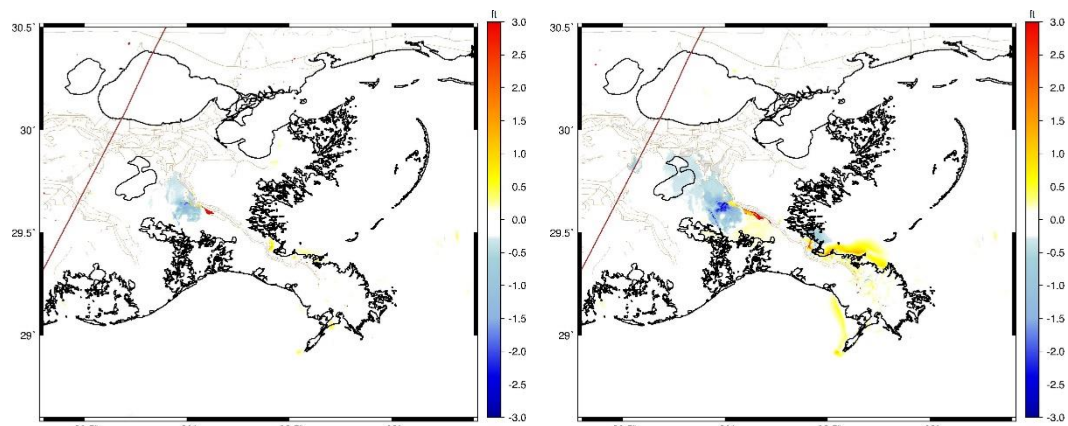


Figure 3-53. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 160, 1 percent AEP storm, year 2040 (left), year 2070 (right).**

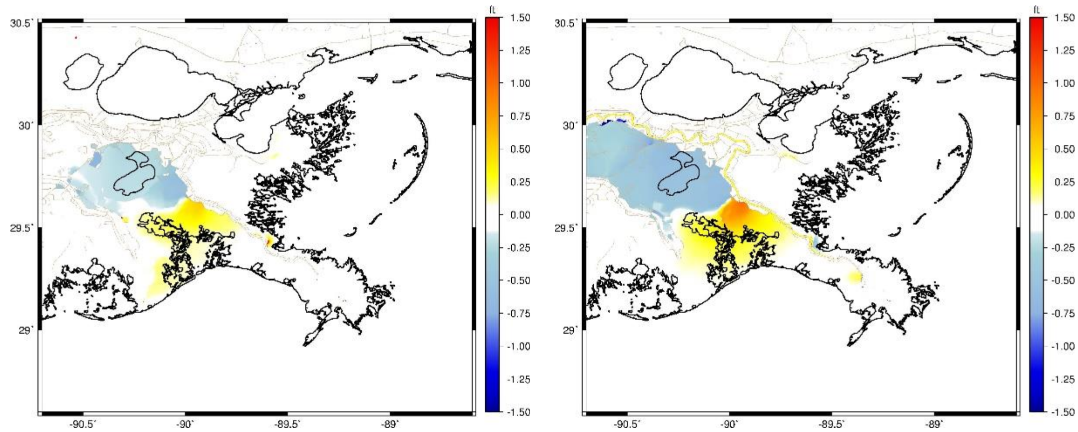


Figure 3-54. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 239, 4 percent AEP storm, year 2040 (left), year 2070 (right).**

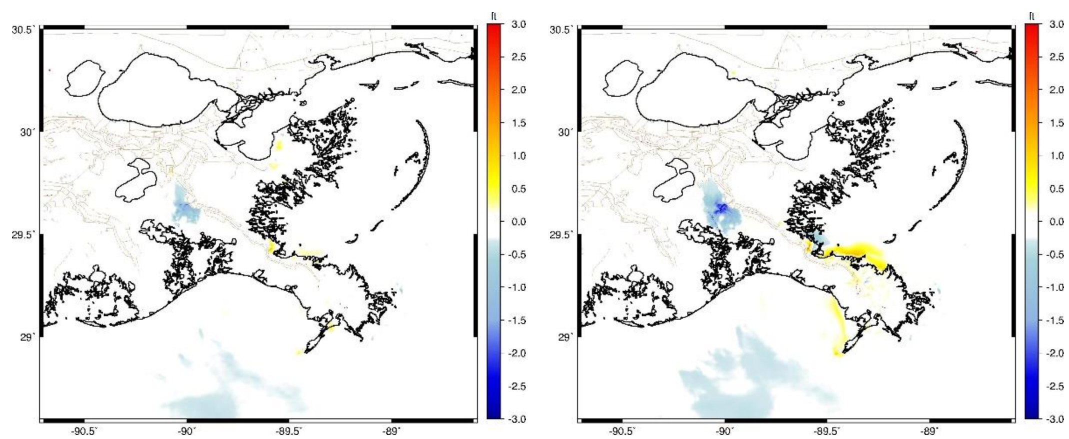


Figure 3-55. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 239, 4 percent AEP storm, year 2040 (left), year 2070 (right).**

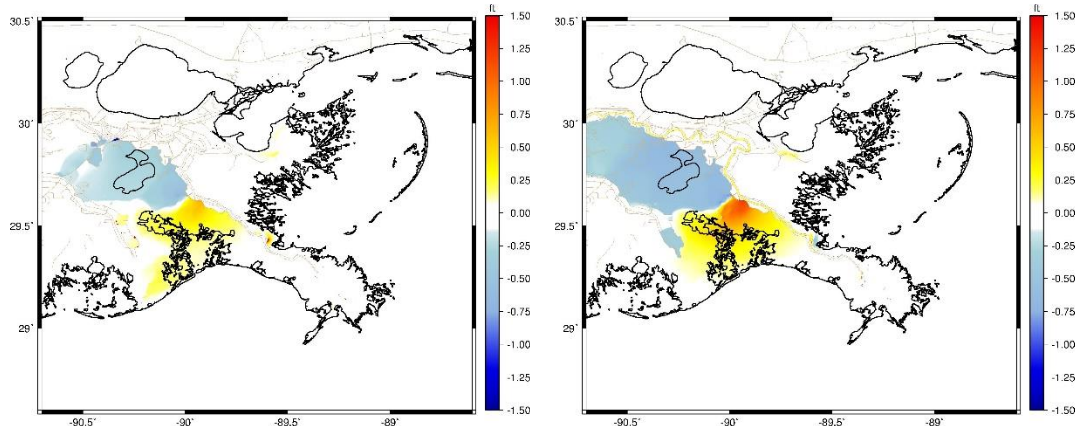


Figure 3-56. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 245, 1 percent AEP storm, year 2040 (left), year 2070 (right).**

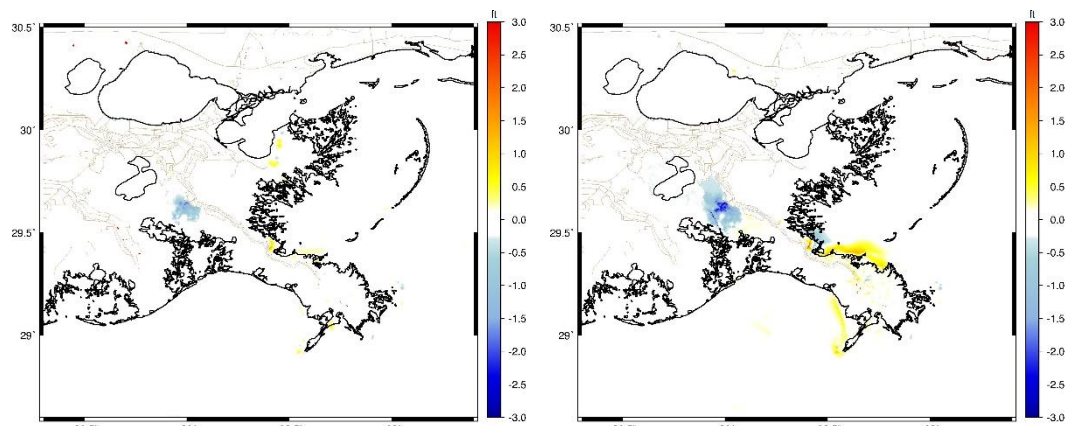


Figure 3-57. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 245, 1 percent AEP storm, year 2040 (left), year 2070 (right).**

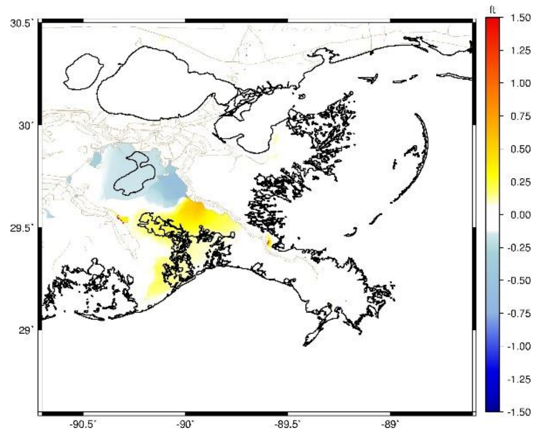


Figure 3-58. Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm 257, 4 percent AEP storm, year 2040 (left), year 2070 (right).

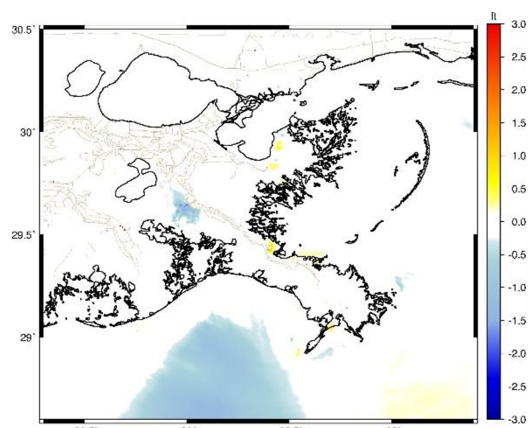


Figure 3-59. Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm 257, 4 percent AEP storm, year 2040 (left), year 2070 (right).

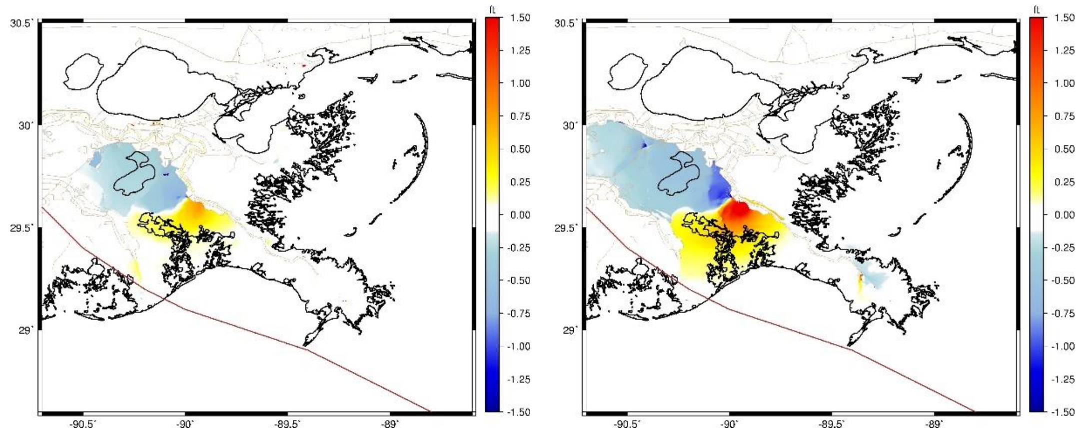


Figure 3-60. **Maximum water surface elevation difference between the Applicant's Preferred Alternative and the No Action Alternative storm Isaac, year 2040 (left), year 2070 (right).**

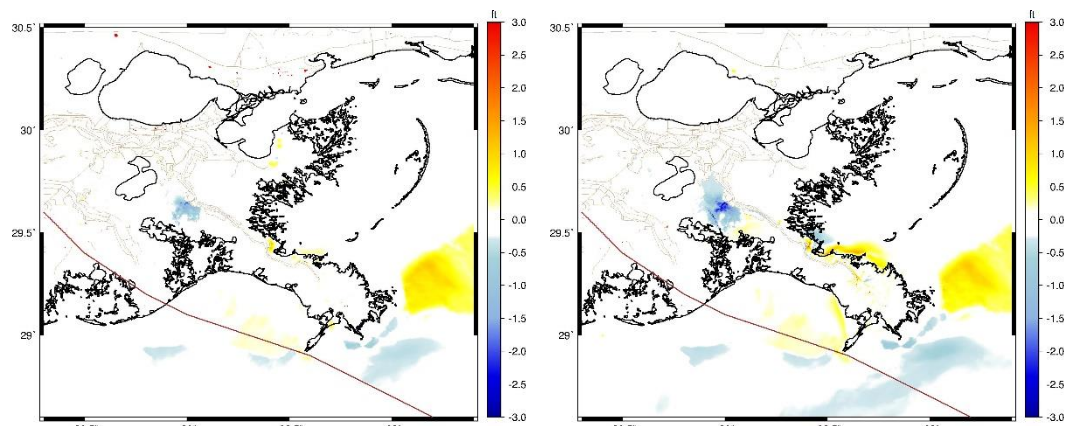


Figure 3-61. **Maximum wave height difference between the Applicant's Preferred Alternative and the No Action Alternative for storm Isaac, year 2040 (left), year 2070 (right).**

Figures 3-62 through 3-77 show hydrographs that display the water surface elevation for a representative 1 percent AEP and 4 percent AEP simulated storm at each data extraction, or “save,” point for 2040 and 2070.

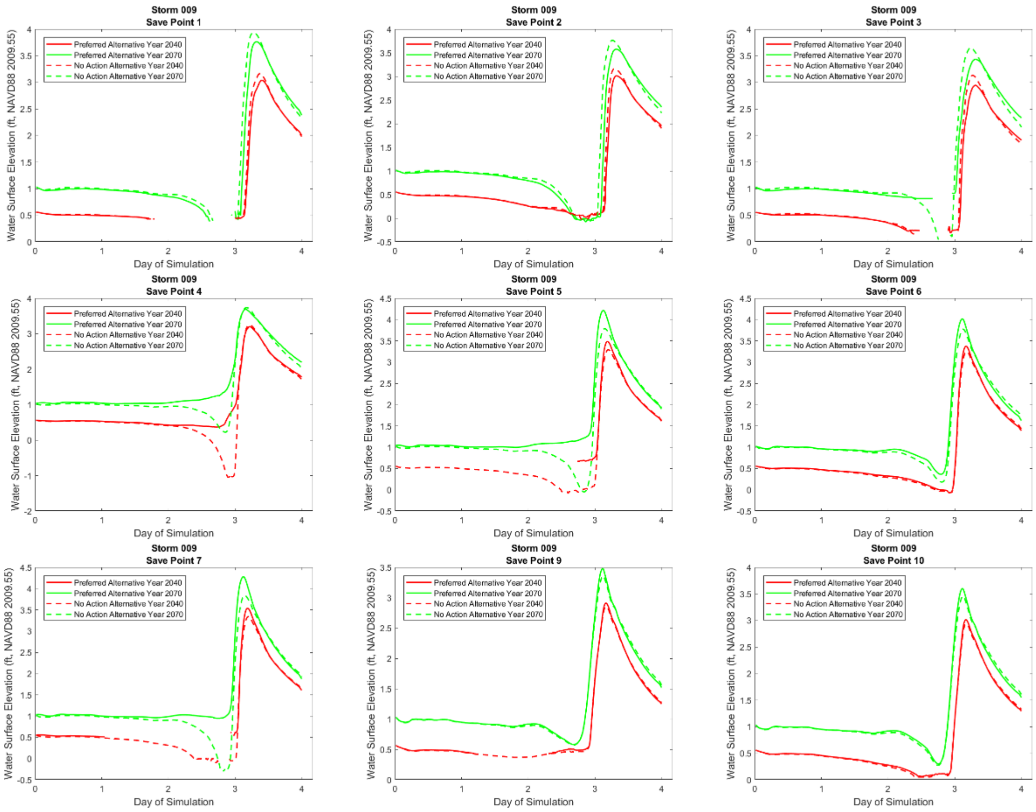


Figure 3-62. Hydrographs at selected save points along the NOV-NFL for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant’s Preferred Alternative (red solid 2040, green solid 2070).

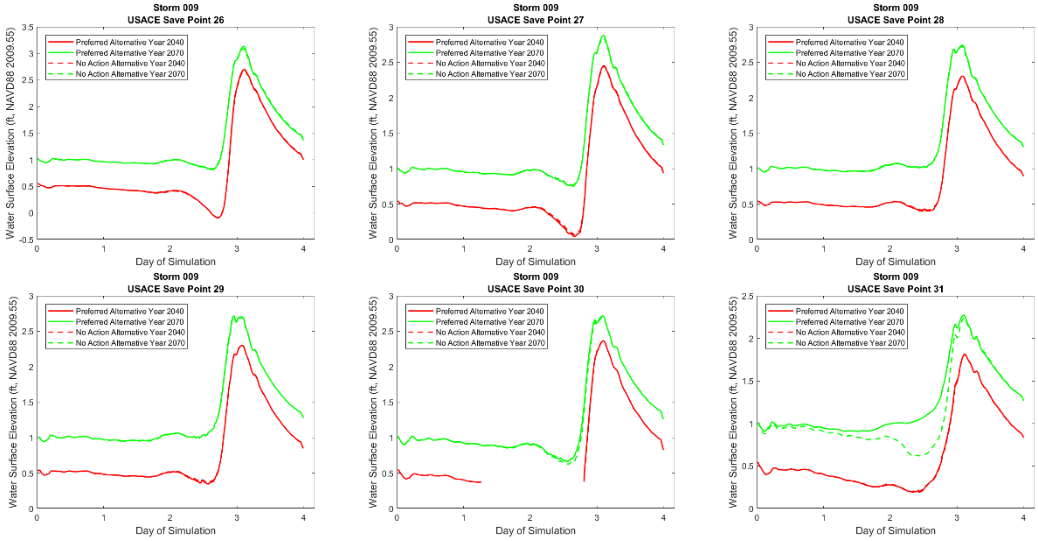


Figure 3-63. Hydrographs at selected save points along the NOV for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

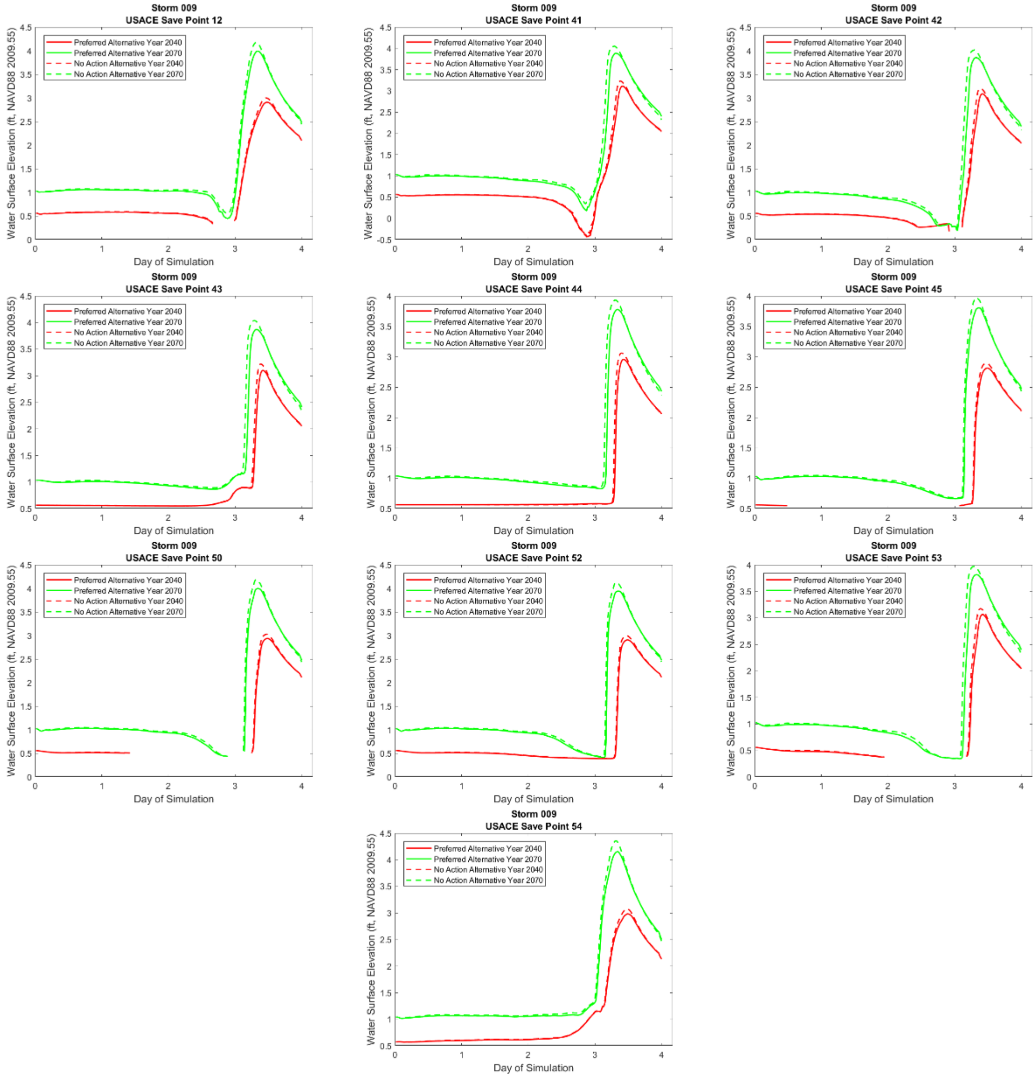


Figure 3-64. Hydrographs at selected save points along the WBV for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

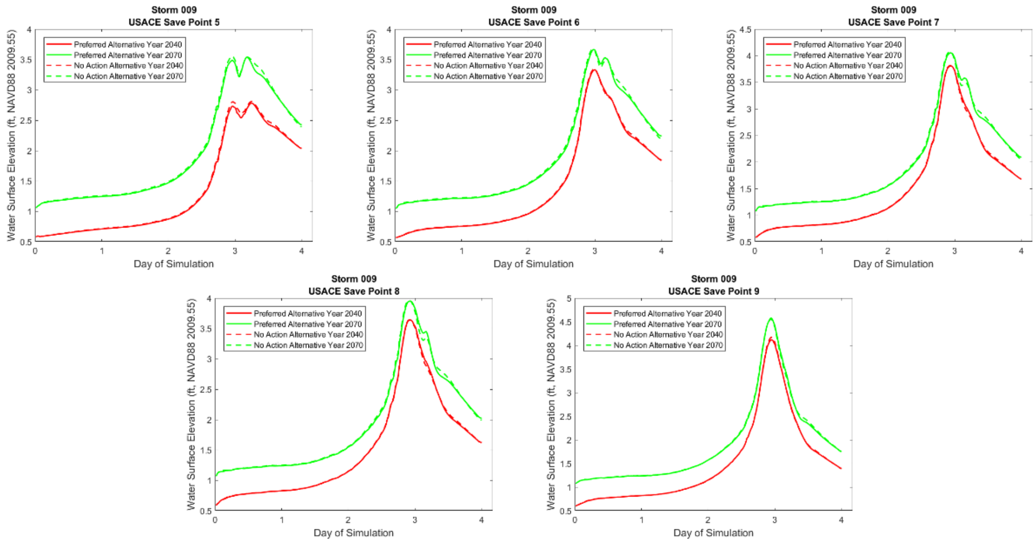


Figure 3-65. Hydrographs at selected save points near the LGM for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

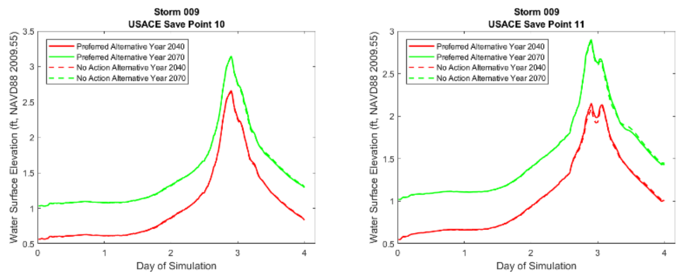


Figure 3-66. Hydrographs at selected save points near Grand Isle for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

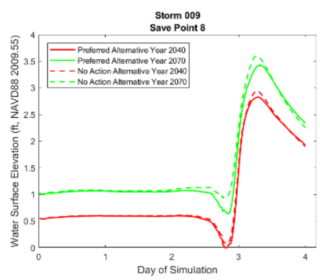


Figure 3-67. Hydrographs at a save point near Lafitte for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

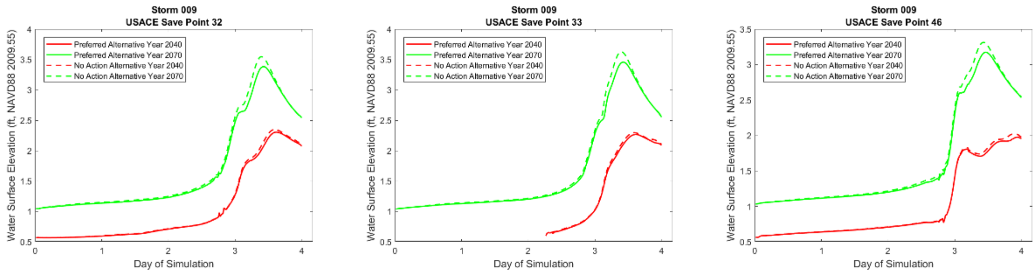


Figure 3-68. **Hydrographs at selected save points near Des Allemandes/ Bayou Gauche for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).**

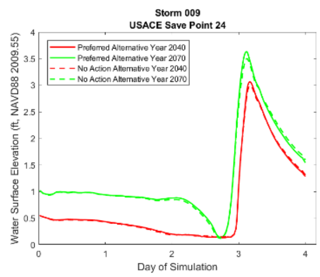


Figure 3-69. **Hydrographs at a save point near Grand Bayou for storm 009, 1 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).**

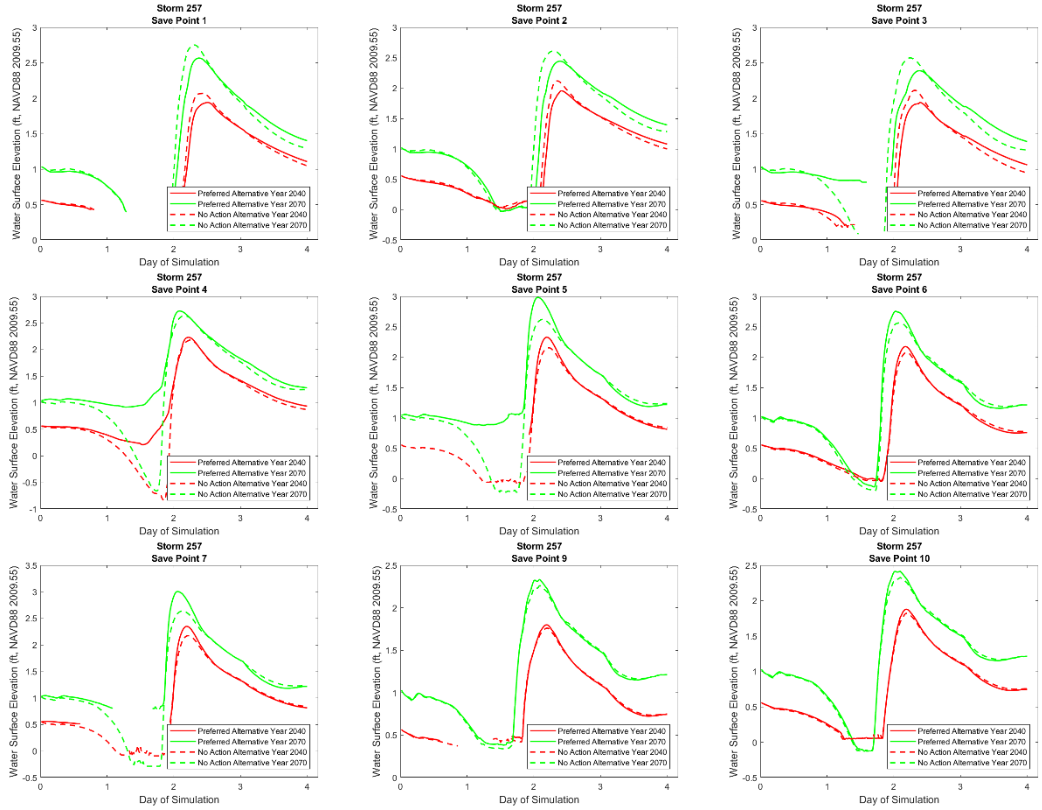


Figure 3-70. **Hydrographs at selected save points along the NOV-NFL for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).**

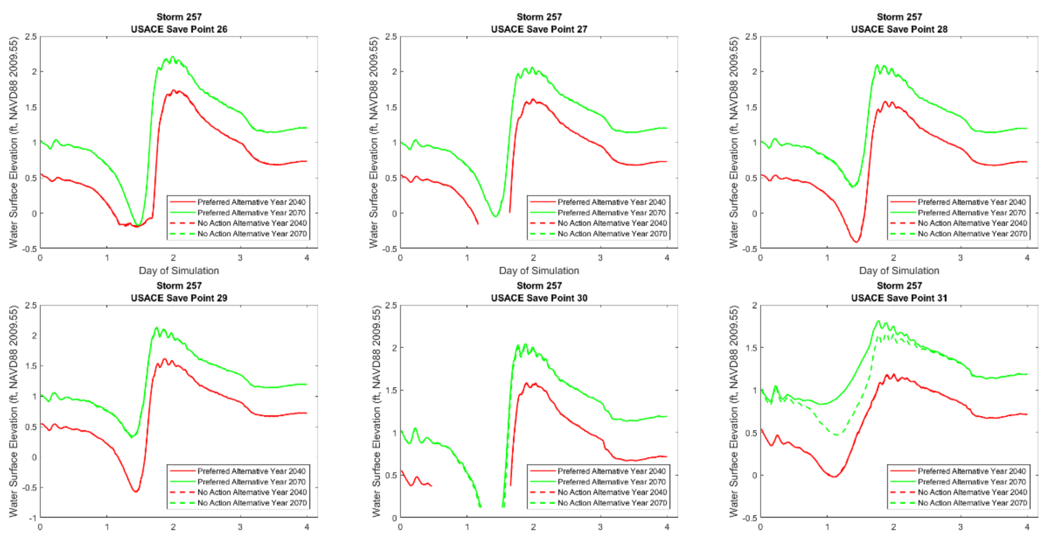


Figure 3-71. **Hydrographs at selected save points along the NOV for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).**

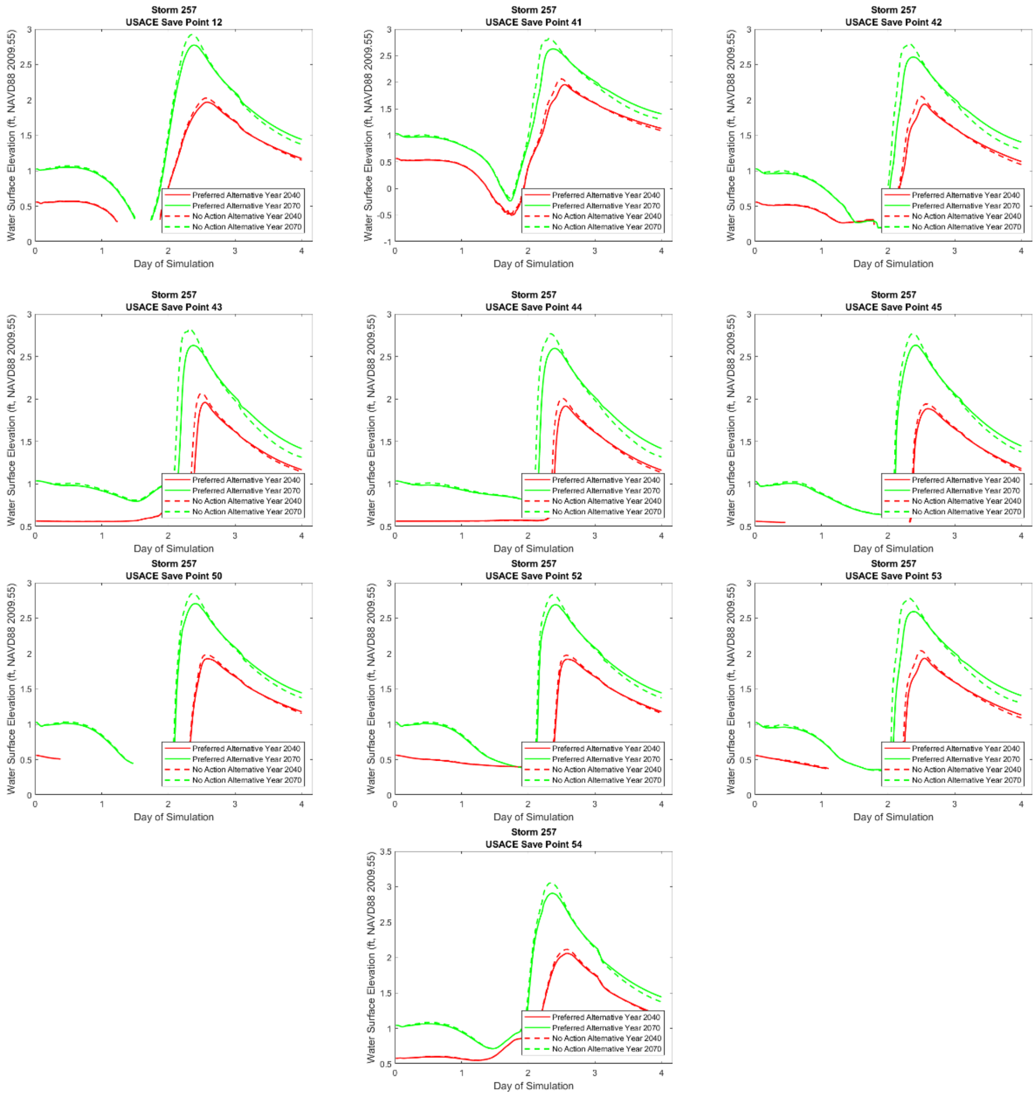


Figure 3-72. Hydrographs at selected save points along the WBV for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

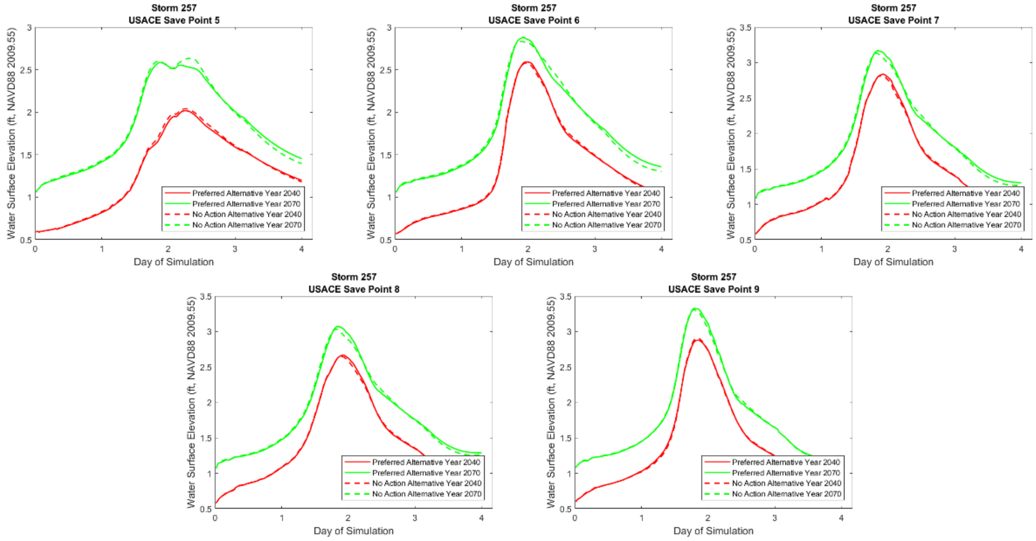


Figure 3-73. **Hydrographs at selected save points near the LGM for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).**

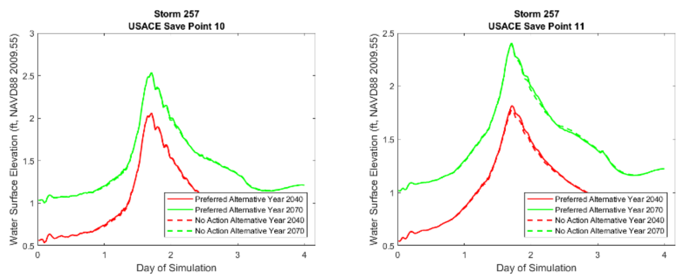


Figure 3-74. **Hydrographs at selected save points near Grand Isle for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).**

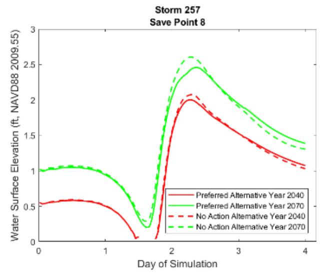


Figure 3-75. Hydrographs at a save point near Lafitte for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

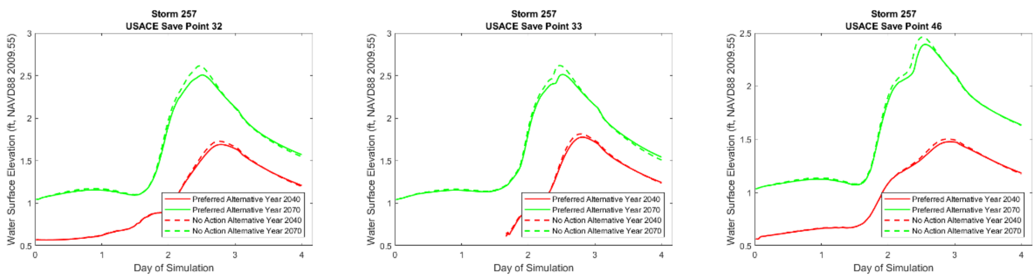


Figure 3-76. Hydrographs at selected save points near Des Allemandes/ Bayou Gauche for storm 257, 4 percent AEP storm, showing water surface elevation the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

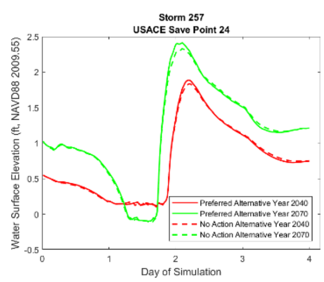


Figure 3-77. Hydrographs at a save point near Grand Bayou for storm 257, 4 percent AEP storm, showing water surface elevation for the No Action Alternative (red hashed 2040, green hashed 2070) and Applicant's Preferred Alternative (red solid 2040, green solid 2070).

Tables 3-7 through 3-10 below list the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP simulated storms at each save point used in the analysis for 2040 and 2070.

Table 3-7
Summary of Surge Elevation differences between the Applicant's Preferred Alternative 2040 and the No Action Alternative 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 11	0.0	0.2	0.1	0.0	0.1	0.1
WBV	USACE 54	-0.4	-0.3	-0.3	-0.3	-0.2	-0.3
	USACE 12	-0.4	-0.3	-0.3	-0.3	-0.2	-0.3
	USACE 50	-0.5	-0.3	-0.3	-0.3	-0.2	-0.3
	USACE 52	-0.5	-0.3	-0.3	-0.3	-0.2	-0.3
	USACE 45	-0.6	-0.3	-0.3	-0.3	-0.2	-0.3
	USACE 44	-0.6	-0.3	-0.5	-0.5	-0.3	-0.4
	USACE 43	-0.7	-0.4	-0.5	-0.6	-0.4	-0.5
	USACE 41	-0.7	-0.4	-0.5	-0.6	-0.4	-0.5
	USACE 42	-0.7	-0.4	-0.5	-0.6	-0.4	-0.5
	USACE 53	-0.6	-0.4	-0.5	-0.6	-0.3	-0.5
LGM	USACE 5	-0.3	-0.1	-0.2	-0.2	-0.1	-0.2
	USACE 6	-0.1	0.0	-0.1	-0.1	0.1	0.0
	USACE 7	-0.1	0.0	-0.1	-0.1	0.1	0.0
	USACE 8	-0.1	0.0	0.0	-0.1	0.1	0.0
	USACE 9	-0.3	-0.1	-0.2	-0.2	-0.1	-0.1
Des Allemandes/ Bayou Gauche	USACE 46	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1
	USACE 32	-0.2	-0.1	-0.2	-0.2	-0.1	-0.2
	USACE 33	-0.2	-0.1	-0.1	-0.2	-0.1	-0.2
Grand Bayou	USACE 24	0.2	0.3	0.2	0.1	0.2	0.2
NOV	USACE 26	0.0	0.1	0.1	0.0	0.1	0.0
	USACE 27	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 28	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 29	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 30	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 31	0.0	0.0	0.0	0.0	0.0	0.0
NOV-NFL	Arcadis 1	-0.7	-0.4	-0.5	-0.6	-0.4	-0.5
	Arcadis 2	-0.6	-0.5	-0.6	-0.7	-0.5	-0.6
	Arcadis 3	-0.8	-0.6	-0.7	-0.7	-0.6	-0.6
	Arcadis 4	-0.2	-0.2	-0.2	-0.1	0.2	0.0
	Arcadis 5	0.5	0.7	0.6	0.5	0.7	0.6
	Arcadis 6	0.4	0.4	0.4	0.3	0.4	0.3
	Arcadis 7	0.5	0.7	0.6	0.5	0.7	0.6
	Arcadis 9	0.1	0.2	0.2	0.1	0.1	0.1
	Arcadis 10	0.2	0.3	0.2	0.2	0.2	0.2
Lafitte	Arcadis 8	-0.5	-0.4	-0.4	-0.4	-0.2	-0.3

Table 3-8
Summary of Surge Elevation differences between the Applicant's Preferred Alternative 2070 and the No Action Alternative 2070

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	0.0	0.0	0.0	0.0	0.1	0.0
	USACE 11	0.0	0.1	0.0	0.0	0.1	0.1
WBV	USACE 54	-0.9	-0.5	-0.7	-0.7	-0.5	-0.6
	USACE 12	-0.9	-0.5	-0.7	-0.7	-0.5	-0.6
	USACE 50	-0.7	-0.4	-0.5	-0.7	-0.5	-0.6
	USACE 52	-0.7	-0.4	-0.6	-0.6	-0.5	-0.6
	USACE 45	-1.0	-0.4	-0.6	-0.6	-0.5	-0.6
	USACE 44	-0.9	-0.5	-0.7	-0.8	-0.6	-0.7
	USACE 43	-0.8	-0.6	-0.7	-1.0	-0.6	-0.8
	USACE 41	-0.9	-0.6	-0.7	-1.1	-0.5	-0.8
	USACE 42	-0.8	-0.5	-0.7	-1.0	-0.5	-0.8
	USACE 53	-0.8	-0.5	-0.7	-1.0	-0.6	-0.8
LGM	USACE 5	-0.5	0.0	-0.2	-0.3	-0.2	-0.2
	USACE 6	-0.3	0.1	-0.1	-0.2	0.2	0.0
	USACE 7	-0.2	0.1	-0.1	-0.2	0.3	0.0
	USACE 8	-0.2	0.1	-0.1	-0.2	0.3	0.0
	USACE 9	-0.1	0.1	0.0	-0.1	0.2	0.0
Des Allemandes/ Bayou Gauche	USACE 46	-0.6	-0.2	-0.4	-0.5	-0.2	-0.4
	USACE 32	-0.6	-0.3	-0.4	-0.5	-0.3	-0.4
	USACE 33	-0.6	-0.3	-0.5	-0.5	-0.3	-0.4
Grand Bayou	USACE 24	0.3	0.5	0.4	0.2	0.4	0.3
NOV	USACE 26	0.0	0.3	0.1	0.1	0.1	0.1
	USACE 27	0.0	0.2	0.1	0.0	0.1	0.1
	USACE 28	0.0	0.2	0.1	0.0	0.0	0.0
	USACE 29	0.0	0.1	0.1	0.0	0.1	0.0
	USACE 30	-0.1	0.1	0.0	0.0	0.1	0.1
	USACE 31	-0.1	0.1	0.0	-0.1	0.5	0.1
NOV-NFL	Arcadis 1	-0.9	-0.6	-0.7	-0.9	-0.6	-0.7
	Arcadis 2	-1.0	-0.6	-0.8	-0.9	-0.5	-0.8
	Arcadis 3	-1.2	-0.7	-0.9	-1.0	-0.6	-0.8
	Arcadis 4	-0.3	0.0	-0.2	-0.2	0.3	0.1
	Arcadis 5	1.1	1.6	1.3	0.9	1.7	1.3
	Arcadis 6	0.6	0.9	0.8	0.5	0.8	0.7
	Arcadis 7	1.2	1.7	1.4	1.0	1.7	1.3
	Arcadis 9	0.3	0.4	0.4	0.2	0.3	0.3
	Arcadis 10	0.4	0.5	0.5	0.3	0.4	0.4
Lafitte	Arcadis 8	-0.8	-0.6	-0.6	-0.7	-0.5	-0.6

Table 3-9
Summary of Wave Height differences between the Applicant's Preferred Alternative 2040 and the No Action Alternative 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	0.0	0.1	0.0	0.0	0.1	0.0
	USACE 11	0.0	0.1	0.0	0.0	0.0	0.0
WBV	USACE 54	-0.1	0.0	0.0	0.0	0.0	0.0
	USACE 12	-0.2	-0.1	-0.1	-0.1	0.0	-0.1
	USACE 50	-0.1	0.0	-0.1	-0.1	0.0	0.0
	USACE 52	-0.2	0.1	-0.1	0.0	0.0	0.0
	USACE 45	-0.1	0.0	0.0	-0.2	0.0	-0.1
	USACE 44	-0.1	0.1	0.0	-0.1	0.3	0.0
	USACE 43	-0.2	-0.1	-0.1	-0.1	0.0	0.0
	USACE 41	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 42	-0.3	-0.1	-0.2	-0.2	-0.1	-0.1
	USACE 53	-0.2	0.0	-0.1	-0.1	0.0	0.0
LGM	USACE 5	-0.1	0.1	0.0	0.0	0.0	0.0
	USACE 6	-0.1	0.0	-0.1	-0.1	0.0	-0.1
	USACE 7	-0.1	0.0	-0.1	-0.1	0.0	0.0
	USACE 8	-0.1	0.0	0.0	0.0	0.0	0.0
	USACE 9	-0.1	-0.1	-0.1	-0.1	0.0	-0.1
Des Allemandes/ Bayou Gauche	USACE 46	-0.1	0.0	0.0	0.0	0.0	0.0
	USACE 32	-0.1	0.0	0.0	-0.1	0.0	0.0
	USACE 33	0.0	0.0	0.0	0.0	0.0	0.0
Grand Bayou	USACE 24	0.0	0.1	0.1	0.0	0.1	0.0
NOV	USACE 26	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 27	0.0	0.1	0.0	0.0	0.0	0.0
	USACE 28	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 29	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 30	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 31	0.0	0.0	0.0	0.0	0.0	0.0
NOV-NFL	Arcadis 1	-0.3	-0.1	-0.2	-0.3	-0.1	-0.2
	Arcadis 2	-0.3	-0.1	-0.3	-0.6	-0.2	-0.3
	Arcadis 3	-0.5	-0.4	-0.5	-0.5	-0.4	-0.4
	Arcadis 4	-1.4	-1.3	-1.3	-1.3	-1.2	-1.3
	Arcadis 5	-0.9	-0.8	-0.8	-0.9	-0.8	-0.9
	Arcadis 6	0.0	0.1	0.1	0.0	0.0	0.0
	Arcadis 7	-0.9	-0.8	-0.9	-0.9	-0.8	-0.9
	Arcadis 9	-0.1	0.0	-0.1	-0.1	0.1	0.0
	Arcadis 10	0.0	0.1	0.1	0.0	0.0	0.0
Lafitte	Arcadis 8	-0.2	-0.1	-0.1	-0.1	0.0	-0.1

Table 3-10
Summary of Wave Height differences between the Applicant's Preferred Alternative 2070 and the No Action Alternative 2070

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	0.0	0.2	0.0	0.0	0.2	0.1
	USACE 11	0.0	0.0	0.0	0.0	0.0	0.0
WBV	USACE 54	-0.2	0.0	-0.1	-0.1	0.0	-0.1
	USACE 12	-0.3	-0.2	-0.2	-0.3	-0.2	-0.2
	USACE 50	-0.1	0.0	-0.1	-0.1	0.0	-0.1
	USACE 52	-0.1	0.0	-0.1	-0.1	0.0	0.0
	USACE 45	-0.1	0.0	0.0	0.0	0.0	0.0
	USACE 44	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1
	USACE 43	-0.3	-0.1	-0.2	-0.2	-0.1	-0.2
	USACE 41	0.0	0.0	0.0	-0.1	0.0	0.0
	USACE 42	-0.5	-0.1	-0.3	-0.4	-0.1	-0.2
	USACE 53	-0.2	0.0	-0.1	-0.1	0.0	-0.1
LGM	USACE 5	-0.1	0.0	0.0	0.0	0.0	0.0
	USACE 6	-0.1	0.0	-0.1	-0.1	0.0	0.0
	USACE 7	-0.1	0.0	-0.1	-0.1	0.0	-0.1
	USACE 8	-0.1	0.0	-0.1	-0.1	0.0	-0.1
	USACE 9	-0.1	0.0	0.0	-0.1	0.0	0.0
Des Allemandes/ Bayou Gauche	USACE 46	-0.1	0.0	0.0	-0.1	0.0	0.0
	USACE 32	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1
	USACE 33	-0.1	-0.1	-0.1	-0.1	0.0	0.0
Grand Bayou	USACE 24	0.1	0.2	0.1	0.1	0.1	0.1
NOV	USACE 26	0.0	0.1	0.0	0.0	0.1	0.0
	USACE 27	0.0	0.1	0.0	0.0	0.0	0.0
	USACE 28	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 29	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 30	0.0	0.0	0.0	0.0	0.0	0.0
	USACE 31	0.0	0.1	0.0	0.0	0.2	0.1
NOV-NFL	Arcadis 1	-0.4	-0.3	-0.3	-0.4	-0.3	-0.3
	Arcadis 2	-0.6	-0.4	-0.4	-0.5	-0.2	-0.4
	Arcadis 3	-1.4	-1.2	-1.3	-1.4	-1.2	-1.3
	Arcadis 4	-2.1	-1.9	-2.0	-2.0	-1.8	-1.9
	Arcadis 5	-1.2	-0.9	-1.1	-1.3	-1.0	-1.2
	Arcadis 6	0.2	0.3	0.2	0.1	0.2	0.2
	Arcadis 7	-0.9	-0.6	-0.8	-0.9	-0.7	-0.8
	Arcadis 9	0.0	0.1	0.0	0.0	0.0	0.0
	Arcadis 10	0.1	0.1	0.1	0.1	0.1	0.1
Lafitte	Arcadis 8	-0.3	-0.2	-0.2	-0.2	-0.1	-0.2

3.3 Other Alternatives – 50,000 cfs Alternative and 150,000 cfs Alternative

In this section Tables 3-11 through 3-14 provide the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP storm selected for analyses of the 50,000 cfs and 150,000 cfs alternatives, at each save point used in the analysis, for 2040 and 2070.

Table 3-11
Summary of Surge Elevation for 50,000 cfs Alternative and 150,000 cfs Alternative in 2040

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.8	10.4	8.6	5.6	7.2	6.5	6.8	10.4	8.6	5.6	7.2	6.6
	USACE 11	5.6	8.5	6.9	4.9	5.9	5.5	5.6	8.5	7.0	5.0	6.3	5.6
WBV	USACE 54	7.9	9.8	8.8	6.5	8.1	7.1	7.6	9.6	8.6	6.3	9.1	7.3
	USACE 12	8.1	9.6	8.7	6.4	7.7	6.9	7.8	9.4	8.4	6.2	8.9	7.1
	USACE 50	8.3	9.7	9.1	6.4	7.9	7.0	8.1	9.5	8.8	6.2	9.3	7.2
	USACE 52	8.2	9.6	9.0	6.3	7.8	6.9	8.0	9.4	8.7	6.2	9.2	7.1
	USACE 45	7.9	9.3	8.7	6.2	7.5	6.7	7.7	9.1	8.4	6.1	8.7	6.9
	USACE 44	8.7	9.9	9.4	6.3	8.4	7.1	8.3	9.5	9.0	6.1	9.3	7.2
	USACE 43	9.3	10.4	9.9	6.5	9.1	7.4	8.8	9.9	9.4	6.3	9.8	7.5
	USACE 41	9.3	10.4	9.9	6.5	9.1	7.4	8.8	9.9	9.4	6.2	9.8	7.5
	USACE 42	9.2	10.5	9.8	6.4	9.0	7.3	8.8	9.9	9.4	6.2	9.8	7.5
	USACE 53	9.1	10.5	9.8	6.4	9.0	7.3	8.7	10.0	9.4	6.2	9.7	7.4
LGM	USACE 5	7.1	9.1	8.1	5.4	7.0	6.3	7.1	9.1	8.0	5.3	8.5	6.6
	USACE 6	9.7	10.9	10.2	6.2	8.7	8.0	9.6	10.9	10.1	6.1	9.5	8.2
	USACE 7	10.8	12.5	11.6	6.5	10.1	8.9	10.7	12.4	11.5	6.5	11.1	9.2
	USACE 8	9.5	12.0	10.8	6.2	9.2	8.2	9.3	11.8	10.7	6.2	10.5	8.6
	USACE 9	10.4	13.5	11.8	6.0	9.7	8.6	10.4	13.5	11.8	6.0	10.7	9.0
Des Allemandes/ Bayou Gauche	USACE 46	4.8	6.5	5.6	4.1	4.9	4.7	4.7	6.3	5.4	4.0	5.5	4.7
	USACE 32	5.7	7.6	6.6	4.8	5.7	5.4	5.6	7.5	6.5	4.7	6.6	5.5
	USACE 33	6.3	7.5	6.8	5.2	6.1	5.9	6.1	7.4	6.7	5.1	7.0	6.0
Grand Bayou	USACE 24	8.8	12.5	10.6	6.1	9.9	7.9	9.0	12.6	10.8	6.3	10.2	8.3

Table 3-11 Summary of Surge Elevation for 50,000 cfs Alternative and 150,000 cfs Alternative in 2040													
Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
NOV	USACE 26	7.7	10.9	9.5	5.7	10.7	7.6	7.7	10.9	9.6	5.7	10.7	7.7
	USACE 27	7.0	10.1	8.8	5.3	10.0	7.0	7.0	10.1	8.8	5.3	10.0	7.1
	USACE 28	6.5	9.1	8.2	5.1	9.6	6.6	6.5	9.1	8.2	5.1	9.6	6.6
	USACE 29	6.5	9.0	8.1	5.1	10.2	6.7	6.5	9.0	8.2	5.1	10.2	6.7
	USACE 30	6.8	9.1	8.3	5.2	10.9	7.0	6.8	9.1	8.3	5.2	10.9	7.0
	USACE 31	5.2	7.8	6.6	3.9	8.4	5.4	5.2	7.8	6.6	3.9	8.4	5.4
NOV-NFL	Arcadis 1	9.1	10.4	9.7	6.4	9.9	7.8	8.8	9.9	9.3	6.2	9.6	7.4
	Arcadis 2	9.2	10.9	9.9	6.5	9.7	7.7	8.9	10.4	9.5	6.2	9.4	7.3
	Arcadis 3	8.9	10.5	9.6	6.5	9.3	7.5	8.7	10.3	9.4	6.2	9.1	7.2
	Arcadis 4	9.4	11.3	10.4	7.2	9.9	8.4	9.5	11.4	10.6	7.4	10.1	8.6
	Arcadis 5	10.1	12.6	11.5	7.6	10.9	9.1	10.2	12.5	11.6	7.7	10.9	9.2
	Arcadis 6	9.7	12.7	11.3	7.1	10.5	8.8	9.9	12.9	11.6	7.3	10.7	9.0
	Arcadis 7	10.3	12.8	11.7	7.7	11.1	9.3	10.3	12.8	11.7	7.7	11.1	9.3
	Arcadis 9	8.4	11.9	10.1	5.9	9.5	7.7	8.5	12.0	10.2	6.0	9.7	7.9
	Arcadis 10	8.7	12.0	10.3	6.1	9.5	7.9	8.8	12.1	10.5	6.3	9.7	8.1
Lafitte	Arcadis 8	8.5	9.3	8.8	6.6	8.4	7.1	8.3	9.1	8.6	6.4	8.2	6.9

Table 3-12
Summary of Surge Elevation for 50,000 cfs Alternative and 150,000 cfs Alternative in 2070

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	8.3	11.8	10.1	7.1	8.6	8.0	8.4	11.9	10.1	7.1	8.7	8.2
	USACE 11	7.6	10.8	9.1	6.7	8.0	7.4	7.7	10.9	9.2	6.7	8.0	7.5
WBV	USACE 54	11.6	13.8	12.5	9.7	12.8	10.7	11.0	13.3	11.9	9.2	9.9	9.7
	USACE 12	11.1	13.2	12.1	9.2	12.2	10.2	10.7	12.7	11.6	8.8	9.4	9.2
	USACE 50	11.0	14.6	12.7	9.0	12.6	10.4	10.7	13.9	12.2	8.6	9.8	9.3
	USACE 52	10.8	14.4	12.5	8.9	12.4	10.2	10.5	13.9	12.1	8.5	9.6	9.2
	USACE 45	10.5	13.4	12.0	8.7	11.8	9.8	10.1	12.7	11.5	8.4	9.1	8.9
	USACE 44	10.6	13.3	12.0	8.6	11.9	9.9	10.1	12.6	11.5	8.2	9.3	8.8
	USACE 43	11.1	13.9	12.5	8.8	12.5	10.3	10.4	13.1	11.9	8.3	9.6	9.0
	USACE 41	11.1	14.1	12.6	8.8	12.5	10.3	10.4	13.3	11.9	8.3	9.6	9.0
	USACE 42	10.9	14.1	12.5	8.7	12.4	10.3	10.3	13.3	11.9	8.2	9.6	9.0
	USACE 53	10.9	14.0	12.4	8.6	12.3	10.2	10.2	13.3	11.8	8.2	9.6	8.9
LGM	USACE 5	10.0	11.6	10.8	7.4	11.2	9.2	9.7	11.5	10.6	8.2	10.0	8.9
	USACE 6	10.5	12.0	11.4	7.9	10.8	9.5	10.4	11.9	11.2	8.9	9.6	9.3
	USACE 7	11.7	13.5	12.7	8.4	12.2	10.4	11.5	13.2	12.5	9.7	11.0	10.4
	USACE 8	10.9	13.3	12.2	8.2	11.8	10.0	10.6	13.0	12.0	9.3	10.3	9.9
	USACE 9	12.2	15.0	13.6	7.9	12.0	10.6	12.2	15.1	13.6	10.0	11.4	10.8
Des Allemandes/ Bayou Gauche	USACE 46	7.7	10.8	9.0	6.7	8.6	7.7	7.5	10.4	8.7	6.5	7.7	7.4
	USACE 32	8.6	11.2	9.6	7.4	9.2	8.3	8.3	10.8	9.3	7.2	8.2	7.9
	USACE 33	8.5	11.5	9.7	7.7	9.6	8.5	8.3	11.0	9.4	7.5	8.3	8.0
Grand Bayou	USACE 24	10.3	14.5	12.4	7.9	11.5	9.9	10.5	14.8	12.7	8.0	11.2	9.4

Table 3-12
Summary of Surge Elevation for 50,000 cfs Alternative and 150,000 cfs Alternative in 2070

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
NOV	USACE 26	9.0	12.3	10.9	7.2	11.7	9.0	9.1	12.5	11.0	7.3	9.6	8.2
	USACE 27	8.3	11.5	10.1	6.7	10.9	8.3	8.4	11.6	10.2	6.8	8.9	7.6
	USACE 28	7.9	10.6	9.6	6.6	10.7	8.1	8.0	10.6	9.7	6.7	8.4	7.4
	USACE 29	7.9	10.6	9.5	6.6	11.2	8.2	7.9	10.6	9.6	6.6	8.3	7.4
	USACE 30	8.0	10.5	9.5	6.6	11.6	8.2	8.0	10.4	9.5	6.6	8.3	7.3
	USACE 31	6.7	8.9	8.0	5.7	9.5	6.9	6.7	9.0	8.0	5.7	6.9	6.2
NOV-NFL	Arcadis 1	10.7	13.8	12.2	8.5	12.0	10.0	10.0	13.0	11.6	8.1	9.3	8.8
	Arcadis 2	10.1	13.7	11.7	8.1	11.3	9.5	9.5	13.0	11.1	7.8	8.9	8.4
	Arcadis 3	9.8	13.1	11.3	7.9	10.7	9.1	9.3	12.5	10.8	7.6	8.6	8.2
	Arcadis 4	10.9	13.9	12.4	8.8	11.5	10.0	11.2	13.9	12.6	9.3	11.0	10.0
	Arcadis 5	12.0	15.6	14.0	9.6	12.9	11.3	12.3	15.6	14.2	9.9	12.3	10.9
	Arcadis 6	11.4	15.3	13.5	8.9	12.2	10.8	11.8	15.9	14.0	9.3	12.2	10.5
	Arcadis 7	12.2	16.0	14.2	9.7	13.1	11.5	12.4	16.0	14.4	9.9	12.5	11.0
	Arcadis 9	9.9	13.8	11.9	7.6	11.0	9.5	10.0	14.0	12.2	7.8	10.7	9.0
	Arcadis 10	10.2	14.0	12.2	7.9	11.2	9.8	10.4	14.4	12.6	8.1	11.0	9.4
Lafitte	Arcadis 8	9.8	11.4	10.7	8.2	10.2	8.8	9.5	10.9	10.3	7.8	8.3	8.1

Table 3-13
Summary of Wave Height for 50,000 cfs Alternative and 150,000 cfs Alternative in 2040

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	5.5	7.3	6.5	3.3	6.0	5.2	5.5	7.3	6.5	3.1	6.2	5.4
	USACE 11	3.3	4.6	3.9	2.5	3.5	3.1	3.3	4.6	3.9	2.3	3.8	3.2
WBV	USACE 54	1.0	1.5	1.4	0.7	1.1	0.9	1.0	1.5	1.3	0.7	1.3	1.0
	USACE 12	2.3	2.8	2.6	1.5	2.3	1.9	2.2	2.7	2.5	1.5	2.8	2.0
	USACE 50	0.5	0.9	0.7	0.3	0.8	0.5	0.5	0.9	0.6	0.3	0.8	0.5
	USACE 52	0.2	0.7	0.5	0.1	0.6	0.3	0.2	0.7	0.4	0.1	0.6	0.4
	USACE 45	0.1	0.8	0.4	0.1	0.5	0.3	0.2	0.7	0.4	0.1	0.8	0.3
	USACE 44	0.4	1.0	0.8	0.2	0.9	0.7	0.4	1.0	0.8	0.2	1.1	0.7
	USACE 43	0.8	1.0	0.9	0.2	1.0	0.6	0.7	0.9	0.9	0.2	1.0	0.7
	USACE 41	0.9	2.1	1.3	0.2	1.1	0.8	0.9	2.1	1.3	0.2	1.2	0.8
	USACE 42	1.6	2.2	1.9	0.2	1.9	1.0	1.5	2.0	1.8	0.2	2.2	1.2
	USACE 53	0.4	1.1	0.6	0.1	0.7	0.4	0.3	1.0	0.6	0.1	0.7	0.4
LGM	USACE 5	2.9	3.8	3.5	1.0	3.0	2.2	2.9	3.7	3.5	1.0	3.3	2.3
	USACE 6	3.3	3.9	3.6	1.2	3.0	2.1	3.2	3.9	3.6	1.2	3.4	2.3
	USACE 7	3.5	4.4	4.1	1.7	3.6	2.5	3.5	4.4	4.0	1.6	3.9	2.7
	USACE 8	3.5	4.5	4.0	2.2	3.6	2.8	3.5	4.4	4.0	2.2	4.0	2.9
	USACE 9	4.0	5.1	4.5	1.8	3.6	3.0	4.0	5.1	4.5	1.8	4.0	3.1
Des Allemandes/ Bayou Gauche	USACE 46	2.1	2.5	2.2	0.5	1.7	1.3	2.1	2.5	2.2	0.4	1.7	1.4
	USACE 32	1.1	1.8	1.6	0.6	1.2	0.9	1.1	1.8	1.5	0.6	1.5	1.0
	USACE 33	0.3	0.5	0.4	0.2	0.8	0.4	0.3	0.5	0.4	0.2	0.8	0.4
Grand Bayou	USACE 24	3.0	4.5	3.7	1.4	3.4	2.4	3.0	4.4	3.7	1.4	3.4	2.5
NOV	USACE 26	3.1	4.4	3.9	0.9	4.3	2.6	3.1	4.4	3.9	0.9	4.3	2.8
	USACE 27	2.1	3.6	2.8	0.4	3.2	1.8	2.1	3.7	2.8	0.4	3.2	1.9
	USACE 28	2.9	4.1	3.6	0.4	4.1	2.4	2.9	4.1	3.6	0.4	4.1	2.5
	USACE 29	3.2	4.2	3.9	0.4	4.6	2.7	3.2	4.2	3.9	0.4	4.6	2.8

Table 3-13
Summary of Wave Height for 50,000 cfs Alternative and 150,000 cfs Alternative in 2040

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
	USACE 30	1.8	2.7	2.4	0.4	3.4	1.7	1.9	2.8	2.5	0.5	3.4	1.7
	USACE 31	2.0	3.3	2.6	0.5	3.3	1.8	2.0	3.3	2.6	0.5	3.3	1.8
NOV-NFL	Arcadis 1	2.0	2.4	2.2	0.2	2.3	1.4	1.9	2.2	2.0	0.2	2.2	1.3
	Arcadis 2	2.4	3.7	3.0	0.1	3.1	1.8	2.2	3.4	2.8	0.1	2.9	1.6
	Arcadis 3	2.4	3.4	2.9	0.1	2.8	1.8	1.7	2.4	2.1	0.1	2.0	1.2
	Arcadis 4	2.8	3.7	3.3	1.9	3.1	2.5	2.7	3.5	3.1	1.8	3.0	2.3
	Arcadis 5	2.8	3.8	3.4	1.9	3.3	2.5	2.6	3.6	3.1	1.6	2.9	2.2
	Arcadis 6	4.0	5.4	4.7	2.9	4.4	3.7	4.0	5.4	4.7	2.9	4.4	3.7
	Arcadis 7	2.7	3.9	3.3	1.8	3.1	2.4	2.5	3.8	3.1	1.5	2.9	2.2
	Arcadis 9	2.1	3.2	2.6	0.4	2.5	1.7	2.1	3.2	2.7	0.3	2.5	1.7
	Arcadis 10	3.0	4.3	3.7	1.2	3.3	2.5	3.0	4.3	3.7	1.0	3.3	2.5
Lafitte	Arcadis 8	3.1	3.4	3.3	2.3	3.2	2.6	3.0	3.4	3.3	2.3	3.1	2.6

Table 3-14
Summary of Wave Height for 50,000 cfs Alternative and 150,000 cfs Alternative in 2070

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.6	7.8	7.3	3.6	6.9	6.0	6.7	7.9	7.4	2.8	6.6	5.5
	USACE 11	3.8	5.6	4.7	2.8	4.4	3.8	3.8	5.6	4.7	2.3	4.2	3.5
WBV	USACE 54	2.1	2.9	2.5	0.9	2.3	1.7	2.0	2.8	2.5	0.9	1.9	1.5
	USACE 12	3.5	4.3	4.0	2.1	4.1	3.1	3.4	4.1	3.8	1.7	3.0	2.5
	USACE 50	1.0	1.9	1.4	0.5	1.4	1.0	0.9	1.8	1.3	0.5	1.3	0.9
	USACE 52	0.5	1.4	0.8	0.2	0.9	0.6	0.5	1.3	0.8	0.2	0.9	0.5
	USACE 45	0.2	1.2	0.5	0.1	0.5	0.4	0.2	1.1	0.5	0.1	0.5	0.3
	USACE 44	0.7	0.8	0.8	0.5	0.8	0.6	0.6	0.8	0.7	0.4	0.5	0.5
	USACE 43	1.4	1.7	1.5	0.4	1.6	1.1	1.3	1.5	1.4	0.4	1.0	0.8
	USACE 41	1.1	2.2	1.5	0.3	1.5	1.0	1.1	2.2	1.4	0.3	1.2	0.8
	USACE 42	2.3	4.0	3.1	0.4	3.4	2.1	2.2	3.6	2.9	0.4	2.3	1.5
	USACE 53	0.6	2.1	1.2	0.2	1.1	0.8	0.6	1.9	1.1	0.2	0.9	0.6
LGM	USACE 5	3.5	4.4	4.0	1.5	3.5	2.8	3.5	4.4	4.0	1.3	3.3	2.6
	USACE 6	3.9	4.6	4.3	1.7	4.1	3.1	3.8	4.5	4.3	1.3	3.7	2.9
	USACE 7	4.1	5.0	4.7	2.2	4.5	3.4	4.0	4.9	4.6	1.7	4.1	3.1
	USACE 8	4.0	5.1	4.7	2.8	4.6	3.5	4.0	5.0	4.6	2.2	4.1	3.2
	USACE 9	4.7	5.9	5.3	2.5	4.7	3.9	4.7	5.9	5.3	2.7	4.3	3.8
Des Allemandes/ Bayou Gauche	USACE 46	2.2	2.8	2.4	0.7	2.0	1.6	2.2	2.8	2.4	0.7	1.8	1.5
	USACE 32	2.4	3.2	2.8	0.9	2.8	2.1	2.4	3.1	2.8	0.7	2.4	1.9
	USACE 33	0.6	1.2	1.0	0.6	1.1	0.8	0.6	1.1	0.9	0.6	0.9	0.7
Grand Bayou	USACE 24	3.8	5.5	4.6	2.1	4.2	3.4	3.8	5.5	4.7	2.0	4.1	3.0
NOV	USACE 26	3.9	5.3	4.6	1.3	5.0	3.4	3.9	5.3	4.7	1.2	4.1	2.9
	USACE 27	2.6	4.1	3.3	0.7	3.6	2.3	2.6	4.1	3.3	0.6	3.0	1.9
	USACE 28	3.8	5.0	4.5	0.6	5.1	3.3	3.8	5.0	4.6	0.6	4.1	2.7
	USACE 29	4.1	5.1	4.7	0.7	5.3	3.5	4.1	5.1	4.7	0.6	4.2	2.9

Table 3-14
Summary of Wave Height for 50,000 cfs Alternative and 150,000 cfs Alternative in 2070

Levee System/ Community	Save Point	50,000 cfs						150,000 cfs					
		1% AEP Storms			4% AEP Storms			1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
	USACE 30	2.5	3.5	3.1	0.7	4.0	2.3	2.6	3.5	3.2	0.6	2.7	1.8
	USACE 31	2.0	2.9	2.5	0.8	3.0	1.8	2.0	3.0	2.5	0.6	2.1	1.5
NOV-NFL	Arcadis 1	3.3	4.4	3.8	0.4	3.8	2.5	3.0	4.1	3.5	0.4	2.7	1.9
	Arcadis 2	2.9	4.8	3.6	0.3	3.7	2.4	2.3	4.2	3.1	0.3	2.3	1.4
	Arcadis 3	2.5	3.8	3.0	0.4	2.9	1.9	1.4	2.5	1.8	0.3	1.1	0.7
	Arcadis 4	2.8	4.0	3.4	0.4	3.0	2.1	2.5	3.7	3.1	0.4	2.4	1.6
	Arcadis 5	3.3	4.6	4.0	0.4	3.6	2.6	2.8	4.0	3.4	0.4	2.6	1.7
	Arcadis 6	4.8	6.6	5.7	0.5	5.2	3.8	4.9	6.5	5.7	0.5	4.9	3.3
	Arcadis 7	3.7	5.2	4.5	0.5	4.0	2.9	2.8	4.5	3.6	0.5	2.9	1.8
	Arcadis 9	3.2	4.6	3.9	1.6	3.6	2.8	3.3	4.7	4.1	0.8	3.5	2.3
	Arcadis 10	3.9	5.3	4.6	2.7	4.2	3.5	3.9	5.4	4.7	2.3	4.1	3.2
Lafitte	Arcadis 8	3.8	4.5	4.1	0.5	4.0	2.8	3.6	4.2	3.9	0.5	3.2	2.3

3.4 No Action Alternative + Reasonably Foreseeable Other Projects

In this section Tables 3-15 through 3-16 provide the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP storm selected for analyses of the No Action Alternative + Reasonably Foreseeable Other Projects at each save point used in the analysis, for 2040.

Table 3-15
Summary of Surge Elevation for No Action Alternative + Reasonably Foreseeable Other Projects in 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.8	10.3	8.5	5.6	7.2	6.6
	USACE 11	5.5	8.3	6.8	4.9	5.8	5.5
WBV	USACE 54	8.2	10.0	9.0	6.7	7.4	7.0
	USACE 12	8.4	9.8	8.9	6.6	7.1	6.8
	USACE 50	8.5	9.9	9.3	6.5	7.1	6.8
	USACE 52	8.3	9.7	9.2	6.4	7.1	6.8
	USACE 45	8.1	9.4	8.9	6.3	6.8	6.6
	USACE 44	9.1	10.3	9.7	6.5	7.2	7.0
	USACE 43	9.7	10.9	10.2	6.7	7.6	7.3
	USACE 41	9.7	10.9	10.3	6.7	7.6	7.3
	USACE 42	9.6	11.0	10.2	6.7	7.6	7.2
	USACE 53	9.5	10.9	10.2	6.6	7.6	7.2
LGM	USACE 5	7.2	9.2	8.2	6.3	7.1	6.6
	USACE 6	9.7	11.0	10.3	8.1	8.8	8.4
	USACE 7	10.8	12.5	11.6	8.8	10.2	9.5
	USACE 8	9.5	11.9	10.8	8.2	9.3	8.7
	USACE 9	10.9	13.8	12.2	8.8	10.0	9.5
Des Allemandes/ Bayou Gauche	USACE 46	4.9	6.6	5.6	4.2	5.0	4.8
	USACE 32	5.9	7.7	6.7	4.9	5.8	5.5
	USACE 33	6.4	7.5	6.9	5.3	6.2	5.9
Grand Bayou	USACE 24	8.8	12.4	10.6	6.1	8.9	7.4
NOV	USACE 26	7.6	10.8	9.4	5.6	8.1	6.6
	USACE 27	6.9	10.1	8.7	5.2	7.4	6.1
	USACE 28	6.4	9.0	8.1	5.0	6.8	5.7
	USACE 29	6.4	8.9	8.0	5.0	6.6	5.7
	USACE 30	6.5	9.0	8.2	4.9	6.9	5.7
	USACE 31	5.1	7.9	6.5	3.5	5.5	4.4
NOV-NFL	Arcadis 1	9.5	10.9	10.1	6.7	7.7	7.3
	Arcadis 2	9.5	11.4	10.3	6.9	8.1	7.5
	Arcadis 3	9.4	11.1	10.2	6.9	7.9	7.4
	Arcadis 4	9.6	11.5	10.7	7.2	8.5	7.8
	Arcadis 5	9.6	12.1	11.0	7.1	8.9	7.9
	Arcadis 6	9.5	12.4	11.1	6.9	9.2	7.9
	Arcadis 7	9.8	12.4	11.2	7.2	9.1	8.0
	Arcadis 9	8.4	11.7	10.1	5.9	8.5	7.0
	Arcadis 10	8.6	11.8	10.3	6.1	8.6	7.2
Lafitte	Arcadis 8	8.8	9.6	9.1	6.7	7.0	6.8

Table 3-16
Summary of Wave Height for No Action Alternative + Reasonably Foreseeable Other Projects in 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	5.5	7.2	6.5	3.4	5.9	5.0
	USACE 11	3.3	4.5	3.9	2.6	3.5	3.1
WBV	USACE 54	1.0	1.6	1.4	0.7	1.1	0.9
	USACE 12	2.4	2.8	2.6	1.5	2.1	1.8
	USACE 50	0.5	1.0	0.7	0.3	0.8	0.5
	USACE 52	0.2	0.8	0.5	0.1	0.6	0.3
	USACE 45	0.1	0.8	0.4	0.1	0.3	0.2
	USACE 44	0.5	1.0	0.8	0.3	0.9	0.6
	USACE 43	1.0	1.1	1.0	0.2	0.7	0.6
	USACE 41	0.9	2.1	1.3	0.2	1.1	0.7
	USACE 42	1.7	2.4	2.1	0.2	1.3	0.9
	USACE 53	0.4	1.2	0.7	0.2	0.6	0.4
LGM	USACE 5	3.0	3.8	3.5	1.1	3.0	2.2
	USACE 6	3.3	4.0	3.7	1.3	3.1	2.4
	USACE 7	3.6	4.5	4.1	1.7	3.7	2.7
	USACE 8	3.5	4.5	4.0	2.6	3.6	3.0
	USACE 9	4.1	5.2	4.6	3.2	3.6	3.4
Des Allemandes/ Bayou Gauche	USACE 46	2.1	2.6	2.2	0.5	1.8	1.3
	USACE 32	1.1	1.8	1.6	0.6	1.2	1.0
	USACE 33	0.3	0.5	0.4	0.2	0.8	0.4
Grand Bayou	USACE 24	3.0	4.4	3.7	1.4	3.0	2.1
NOV	USACE 26	3.1	4.4	3.9	0.9	3.3	2.2
	USACE 27	2.1	3.6	2.8	0.4	2.5	1.4
	USACE 28	2.9	4.1	3.6	0.4	3.1	2.0
	USACE 29	3.2	4.2	3.8	0.4	3.3	2.2
	USACE 30	1.8	2.8	2.5	0.5	1.9	1.2
	USACE 31	1.8	3.3	2.5	0.5	2.1	1.3
NOV-NFL	Arcadis 1	2.0	2.6	2.3	0.2	1.6	1.1
	Arcadis 2	2.7	4.0	3.2	0.1	2.4	1.5
	Arcadis 3	2.8	3.7	3.2	0.1	2.4	1.6
	Arcadis 4	4.1	5.0	4.6	0.0	3.7	2.5
	Arcadis 5	3.6	4.6	4.1	0.0	3.3	2.2
	Arcadis 6	4.0	5.4	4.7	0.1	3.8	2.5
	Arcadis 7	3.4	4.5	4.0	0.1	3.2	2.1
	Arcadis 9	2.5	3.7	3.1	0.5	2.5	1.6
	Arcadis 10	3.0	4.3	3.7	1.4	3.0	2.2
Lafitte	Arcadis 8	3.1	3.5	3.4	2.3	2.5	2.4

3.5 150,000 cfs Alternative + Reasonably Foreseeable Other Projects + Terraces

In this section Tables 3-17 through 3-20 provide the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP storm selected for analyses of the 150,000 cfs Alternative + Reasonably Foreseeable Other Projects + Terraces at each save point used in the analysis, for 2040 and 2070.

Table 3-17
Summary of Surge Elevation for 150,000 cfs Alternative + Reasonably Foreseeable Other Projects + Terraces in 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.8	10.4	8.6	5.6	7.2	6.6
	USACE 11	5.6	8.5	7.0	5.0	6.0	5.6
WBV	USACE 54	7.5	9.5	8.5	6.2	6.9	6.6
	USACE 12	7.7	9.3	8.3	6.1	6.7	6.4
	USACE 50	8.0	9.4	8.7	6.1	6.7	6.4
	USACE 52	7.9	9.3	8.6	6.1	6.6	6.4
	USACE 45	7.6	9.0	8.3	6.0	6.4	6.2
	USACE 44	8.2	9.4	8.8	6.1	6.5	6.3
	USACE 43	8.8	9.8	9.3	6.2	6.7	6.5
	USACE 41	8.7	9.8	9.3	6.1	6.7	6.5
	USACE 42	8.7	9.8	9.3	6.1	6.7	6.5
	USACE 53	8.6	9.8	9.2	6.1	6.6	6.4
LGM	USACE 5	7.0	9.1	8.0	6.1	6.9	6.4
	USACE 6	9.6	10.9	10.1	8.1	8.6	8.4
	USACE 7	10.7	12.4	11.5	8.8	10.0	9.4
	USACE 8	9.3	11.8	10.6	8.1	9.1	8.7
	USACE 9	10.6	13.7	12.0	8.8	9.8	9.4
Des Allemandes/ Bayou Gauche	USACE 46	4.6	6.2	5.4	4.0	4.8	4.6
	USACE 32	5.5	7.4	6.4	4.6	5.5	5.3
	USACE 33	6.1	7.3	6.7	5.1	6.0	5.7
Grand Bayou	USACE 24	9.0	12.7	10.8	6.3	9.0	7.5
NOV	USACE 26	7.7	11.0	9.6	5.7	8.2	6.8
	USACE 27	7.0	10.2	8.8	5.3	7.5	6.2
	USACE 28	6.5	9.1	8.2	5.0	6.8	5.8
	USACE 29	6.4	8.9	8.1	5.0	6.7	5.7
	USACE 30	6.6	9.0	8.2	5.0	6.9	5.8
	USACE 31	5.1	7.8	6.5	3.5	5.4	4.4
NOV-NFL	Arcadis 1	8.7	9.7	9.2	6.1	6.7	6.5
	Arcadis 2	8.8	10.3	9.4	6.1	6.9	6.5
	Arcadis 3	8.6	10.2	9.3	6.1	6.8	6.5
	Arcadis 4	9.5	11.4	10.6	7.4	8.6	7.9
	Arcadis 5	10.2	12.6	11.6	7.7	9.4	8.5
	Arcadis 6	9.9	12.9	11.6	7.3	9.5	8.3
	Arcadis 7	10.4	12.9	11.8	7.8	9.6	8.6
	Arcadis 9	8.5	12.0	10.3	6.0	8.5	7.1
	Arcadis 10	8.8	12.2	10.5	6.3	8.7	7.4
Lafitte	Arcadis 8	8.1	9.0	8.5	6.3	6.6	6.4

Table 3-18
Summary of Surge Elevation for 150,000 cfs Alternative + Reasonably Foreseeable Other Projects + Terraces in 2070

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	8.4	11.9	10.1	7.1	8.7	8.2
	USACE 11	7.7	10.9	9.2	6.7	8.0	7.5
WBV	USACE 54	11.0	13.2	11.9	9.2	9.8	9.6
	USACE 12	10.7	12.6	11.5	8.7	9.3	9.2
	USACE 50	10.6	13.8	12.1	8.5	9.7	9.2
	USACE 52	10.5	13.8	12.0	8.5	9.5	9.1
	USACE 45	10.1	12.6	11.4	8.3	9.1	8.8
	USACE 44	10.1	12.5	11.4	8.2	9.2	8.8
	USACE 43	10.3	13.1	11.8	8.3	9.5	9.0
	USACE 41	10.4	13.2	11.9	8.3	9.5	9.0
	USACE 42	10.2	13.2	11.8	8.2	9.5	8.9
	USACE 53	10.2	13.2	11.7	8.2	9.5	8.9
LGM	USACE 5	9.7	11.5	10.6	8.2	10.0	8.9
	USACE 6	10.4	11.9	11.2	8.9	9.6	9.3
	USACE 7	11.6	13.2	12.5	9.7	11.0	10.4
	USACE 8	10.6	13.0	12.0	9.3	10.3	9.9
	USACE 9	12.3	15.1	13.7	10.1	11.5	10.9
Des Allemandes/ Bayou Gauche	USACE 46	7.4	10.1	8.6	6.4	7.8	7.4
	USACE 32	8.3	10.7	9.3	7.1	8.1	7.8
	USACE 33	8.3	11.0	9.4	7.5	8.3	8.0
Grand Bayou	USACE 24	10.5	14.8	12.7	8.1	11.2	9.4
NOV	USACE 26	9.1	12.5	11.0	7.3	9.6	8.2
	USACE 27	8.4	11.6	10.2	6.8	8.9	7.6
	USACE 28	8.0	10.6	9.7	6.7	8.4	7.4
	USACE 29	7.9	10.5	9.6	6.6	8.3	7.4
	USACE 30	7.9	10.4	9.5	6.5	8.2	7.3
	USACE 31	6.6	9.0	8.0	5.5	6.9	6.0
NOV-NFL	Arcadis 1	10.0	12.9	11.5	8.1	9.3	8.7
	Arcadis 2	9.4	12.9	11.1	7.7	8.9	8.3
	Arcadis 3	9.2	12.5	10.7	7.6	8.6	8.1
	Arcadis 4	11.1	13.8	12.5	9.3	10.9	10.0
	Arcadis 5	12.3	15.6	14.1	9.9	12.3	10.9
	Arcadis 6	11.8	15.9	14.0	9.3	12.2	10.5
	Arcadis 7	12.5	16.0	14.4	9.9	12.5	11.1
	Arcadis 9	10.1	14.0	12.2	7.8	10.7	9.1
	Arcadis 10	10.4	14.4	12.6	8.1	11.0	9.4
Lafitte	Arcadis 8	9.4	10.9	10.2	7.8	8.2	8.0

Table 3-19
Summary of Wave Height for 150,000 cfs Alternative + Reasonably Foreseeable Other Projects + Terraces in 2040

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms			Full Storm Suite		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	5.6	7.2	6.6	3.1	6.0	5.0	3.1	7.2	5.9
	USACE 11	3.3	4.6	3.9	2.3	3.5	3.0	2.3	4.6	3.5
WBV	USACE 54	1.0	1.5	1.3	0.7	1.1	0.9	0.7	1.5	1.1
	USACE 12	2.2	2.7	2.5	1.4	1.8	1.7	1.4	2.7	2.1
	USACE 50	0.5	0.8	0.6	0.3	0.7	0.5	0.3	0.8	0.5
	USACE 52	0.2	0.7	0.4	0.1	0.6	0.3	0.1	0.7	0.4
	USACE 45	0.2	0.7	0.4	0.1	0.3	0.2	0.1	0.7	0.3
	USACE 44	0.4	1.0	0.8	0.2	0.8	0.6	0.2	1.0	0.7
	USACE 43	0.7	0.9	0.8	0.2	0.7	0.5	0.2	0.9	0.7
	USACE 41	0.9	2.1	1.3	0.2	1.1	0.7	0.2	2.1	1.0
	USACE 42	1.5	1.9	1.8	0.2	1.0	0.7	0.2	1.9	1.3
	USACE 53	0.3	0.9	0.5	0.1	0.7	0.3	0.1	0.9	0.4
LGM	USACE 5	2.9	3.7	3.5	1.0	3.0	2.1	1.0	3.7	2.9
	USACE 6	3.2	3.9	3.6	1.2	3.0	2.3	1.2	3.9	3.0
	USACE 7	3.5	4.4	4.0	1.6	3.6	2.6	1.6	4.4	3.4
	USACE 8	3.5	4.4	4.0	2.2	3.5	2.8	2.2	4.4	3.5
	USACE 9	4.0	5.2	4.5	2.9	3.5	3.3	2.9	5.2	4.0
Des Allemandes/ Bayou Gauche	USACE 46	2.1	2.5	2.2	0.4	1.8	1.3	0.4	2.5	1.8
	USACE 32	1.1	1.8	1.5	0.6	1.1	0.9	0.6	1.8	1.3
	USACE 33	0.3	0.5	0.4	0.2	0.8	0.4	0.2	0.8	0.4
Grand Bayou	USACE 24	3.1	4.5	3.8	1.4	3.1	2.2	1.4	4.5	3.1
NOV	USACE 26	3.1	4.4	3.9	0.9	3.3	2.2	0.9	4.4	3.1
	USACE 27	2.1	3.7	2.8	0.4	2.5	1.4	0.4	3.7	2.2
	USACE 28	2.9	4.1	3.6	0.4	3.1	2.0	0.4	4.1	2.9
	USACE 29	3.2	4.2	3.9	0.4	3.4	2.2	0.4	4.2	3.1
	USACE 30	1.9	2.8	2.5	0.4	2.0	1.2	0.4	2.8	1.9
	USACE 31	1.9	3.4	2.6	0.5	2.1	1.3	0.5	3.4	2.0
NOV-NFL	Arcadis 1	1.8	2.1	2.0	0.2	1.2	0.8	0.2	2.1	1.5
	Arcadis 2	2.2	3.4	2.7	0.1	1.5	1.0	0.1	3.4	2.0
	Arcadis 3	1.7	2.4	2.0	0.1	1.2	0.8	0.1	2.4	1.5
	Arcadis 4	2.7	3.5	3.1	1.8	2.2	2.0	1.8	3.5	2.7
	Arcadis 5	2.5	3.5	3.1	1.5	2.2	1.8	1.5	3.5	2.6
	Arcadis 6	4.0	5.4	4.7	2.9	3.8	3.3	2.9	5.4	4.2
	Arcadis 7	2.4	3.7	3.0	1.5	2.2	1.7	1.5	3.7	2.5
	Arcadis 9	2.2	3.3	2.8	0.3	2.2	1.4	0.3	3.3	2.2
	Arcadis 10	3.1	4.4	3.8	1.0	3.0	2.1	1.0	4.4	3.0
Lafitte	Arcadis 8	3.0	3.3	3.2	2.2	2.4	2.3	2.2	3.3	2.9

Table 3-20
Summary of Wave Height for 150,000 cfs Alternative + Reasonably Foreseeable Other Projects + Terraces in 2070

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms			Full Storm Suite		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.7	7.8	7.4	2.7	6.7	5.5	2.7	7.8	6.6
	USACE 11	3.8	5.6	4.7	2.3	4.1	3.5	2.3	5.6	4.2
WBV	USACE 54	2.0	2.8	2.5	0.9	1.9	1.5	0.9	2.8	2.0
	USACE 12	3.4	4.1	3.8	1.7	3.0	2.5	1.7	4.1	3.2
	USACE 50	0.9	1.8	1.3	0.5	1.3	0.9	0.5	1.8	1.1
	USACE 52	0.5	1.3	0.8	0.2	0.9	0.5	0.2	1.3	0.7
	USACE 45	0.2	1.1	0.5	0.1	0.5	0.3	0.1	1.1	0.4
	USACE 44	0.6	0.8	0.7	0.4	0.5	0.5	0.4	0.8	0.6
	USACE 43	1.3	1.5	1.4	0.4	0.9	0.8	0.4	1.5	1.1
	USACE 41	1.1	2.2	1.4	0.3	1.2	0.8	0.3	2.2	1.2
	USACE 42	2.2	3.6	2.9	0.4	2.3	1.4	0.4	3.6	2.3
	USACE 53	0.6	1.9	1.1	0.2	0.9	0.6	0.2	1.9	0.9
LGM	USACE 5	3.5	4.4	4.0	1.3	3.3	2.5	1.3	4.4	3.3
	USACE 6	3.8	4.5	4.2	1.3	3.7	2.9	1.3	4.5	3.6
	USACE 7	4.1	4.9	4.6	1.7	4.1	3.1	1.7	4.9	3.9
	USACE 8	4.0	5.0	4.6	2.1	4.1	3.2	2.1	5.0	4.0
	USACE 9	4.7	5.9	5.3	2.7	4.3	3.8	2.7	5.9	4.6
Des Allemandes/ Bayou Gauche	USACE 46	2.2	2.8	2.4	0.7	1.8	1.5	0.7	2.8	2.0
	USACE 32	2.4	3.1	2.8	0.7	2.4	1.9	0.7	3.1	2.4
	USACE 33	0.6	1.1	0.9	0.6	0.9	0.7	0.6	1.1	0.8
Grand Bayou	USACE 24	3.9	5.6	4.7	2.0	4.1	3.0	2.0	5.6	4.0
NOV	USACE 26	3.9	5.3	4.7	1.2	4.1	2.9	1.2	5.3	3.9
	USACE 27	2.6	4.2	3.4	0.6	3.0	1.9	0.6	4.2	2.7
	USACE 28	3.9	5.1	4.6	0.5	4.1	2.7	0.5	5.1	3.8
	USACE 29	4.1	5.1	4.7	0.5	4.2	2.9	0.5	5.1	3.9
	USACE 30	2.6	3.5	3.2	0.6	2.7	1.8	0.6	3.5	2.6
	USACE 31	2.2	3.4	2.8	0.6	2.4	1.5	0.6	3.4	2.2
NOV-NFL	Arcadis 1	3.0	4.1	3.5	0.4	2.7	1.8	0.4	4.1	2.8
	Arcadis 2	2.3	4.2	3.1	0.3	2.3	1.5	0.3	4.2	2.4
	Arcadis 3	1.4	2.5	1.8	0.3	1.1	0.7	0.3	2.5	1.3
	Arcadis 4	2.5	3.7	3.1	0.4	2.4	1.6	0.4	3.7	2.4
	Arcadis 5	2.6	3.9	3.3	0.4	2.4	1.5	0.4	3.9	2.5
	Arcadis 6	4.9	6.5	5.7	0.4	4.9	3.3	0.4	6.5	4.6
	Arcadis 7	2.5	4.0	3.2	0.5	2.5	1.6	0.5	4.0	2.5
	Arcadis 9	3.3	4.8	4.1	0.8	3.5	2.3	0.8	4.8	3.3
	Arcadis 10	3.9	5.4	4.8	2.3	4.1	3.2	2.3	5.4	4.1
Lafitte	Arcadis 8	3.6	4.2	3.8	0.4	3.1	2.3	0.4	4.2	3.1

3.6 No Action Alternative + Terraces

In this section Tables 3-21 through 3-22 provide the minimum, maximum, and mean surge elevations and wave heights for the 1 percent AEP and 4 percent AEP storm selected for analyses of the No Action Alternative + Terraces at each save point used in the analysis, for 2020.

Table 3-21
Summary of Surge Elevation for No Action Alternative + Terraces in 2020

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	6.7	9.0	7.9	6.3	6.6	6.4
	USACE 11	4.7	6.6	5.6	4.5	5.0	4.7
WBV	USACE 54	6.5	7.3	6.9	5.2	5.8	5.5
	USACE 12	6.6	7.1	6.8	5.1	5.5	5.3
	USACE 50	7.1	7.7	7.4	5.4	5.4	5.4
	USACE 52	7.0	7.6	7.3	5.3	5.4	5.4
	USACE 45	6.8	7.4	7.1	5.2	5.3	5.2
	USACE 44	7.6	8.2	7.9	5.4	5.4	5.4
	USACE 43	8.1	8.7	8.4	5.5	5.6	5.6
	USACE 41	8.1	8.7	8.4	5.5	5.6	5.6
	USACE 42	8.0	8.7	8.4	5.5	5.6	5.5
	USACE 53	8.0	8.8	8.4	5.5	5.5	5.5
LGM	USACE 5	5.7	6.2	6.0	5.2	5.7	5.4
	USACE 6	9.4	9.5	9.4	7.5	8.1	7.8
	USACE 7	10.2	10.4	10.3	9.1	9.4	9.3
	USACE 8	8.7	9.7	9.2	8.1	8.5	8.3
	USACE 9	9.7	10.9	10.3	8.6	9.0	8.8
Des Allemandes/ Bayou Gauche	USACE 46	3.9	4.5	4.2	3.2	3.9	3.6
	USACE 32	4.7	5.4	5.0	3.8	4.6	4.2
	USACE 33	5.1	5.8	5.5	4.1	5.0	4.6
Grand Bayou	USACE 24	9.1	11.4	10.2	6.6	7.7	7.2
NOV	USACE 26	8.5	10.1	9.3	6.3	7.4	6.8
	USACE 27	7.8	9.5	8.7	5.7	6.6	6.2
	USACE 28	7.9	8.4	8.1	5.3	5.9	5.6
	USACE 29	8.1	8.2	8.2	5.2	5.8	5.5
	USACE 30	8.3	8.5	8.4	5.4	6.1	5.8
	USACE 31	6.1	7.3	6.7	3.9	4.7	4.3
NOV-NFL	Arcadis 1	8.1	8.8	8.5	5.7	5.9	5.8
	Arcadis 2	8.7	9.7	9.2	6.1	6.5	6.3
	Arcadis 3	8.8	9.6	9.2	6.3	6.6	6.5
	Arcadis 4	9.2	10.0	9.6	6.8	7.1	6.9
	Arcadis 5	9.4	10.6	10.0	6.9	7.5	7.2
	Arcadis 6	9.7	11.2	10.5	7.1	7.9	7.5
	Arcadis 7	9.6	10.9	10.2	7.1	7.7	7.4
	Arcadis 9	8.8	10.8	9.8	6.5	7.4	6.9
	Arcadis 10	8.9	10.8	9.9	6.4	7.4	6.9
Lafitte	Arcadis 8	7.2	8.1	7.7	5.5	5.8	5.7

Table 3-22
Summary of Wave Height for No Action Alternative + Terraces in 2020

Levee System/ Community	Save Point	1% AEP Storms			4% AEP Storms			Full Storm Suite		
		Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)	Min (ft)	Max (ft)	Mean (ft)
Grand Isle	USACE 10	5.1	7.0	6.0	2.9	5.8	4.4	2.9	7.0	5.2
	USACE 11	3.3	3.8	3.6	2.3	3.2	2.7	2.3	3.8	3.1
WBV	USACE 54	1.0	1.4	1.2	0.6	0.6	0.6	0.6	1.4	0.9
	USACE 12	1.9	2.1	2.0	1.5	1.8	1.7	1.5	2.1	1.8
	USACE 50	0.4	0.7	0.5	0.3	0.7	0.5	0.3	0.7	0.5
	USACE 52	0.3	0.5	0.4	0.2	0.5	0.4	0.2	0.5	0.4
	USACE 45	0.2	0.6	0.4	0.2	0.5	0.4	0.2	0.6	0.4
	USACE 44	0.3	0.4	0.3	0.2	0.5	0.3	0.2	0.5	0.3
	USACE 43	0.7	0.8	0.8	0.4	0.5	0.4	0.4	0.8	0.6
	USACE 41	0.9	2.0	1.5	0.3	1.1	0.7	0.3	2.0	1.1
	USACE 42	1.3	1.7	1.5	0.3	0.9	0.6	0.3	1.7	1.1
	USACE 53	0.3	0.8	0.5	0.3	0.6	0.4	0.3	0.8	0.5
LGM	USACE 5	3.2	3.4	3.3	0.9	2.8	1.9	0.9	3.4	2.6
	USACE 6	3.1	3.6	3.3	1.1	2.7	1.9	1.1	3.6	2.6
	USACE 7	3.4	3.9	3.6	1.5	3.3	2.4	1.5	3.9	3.0
	USACE 8	3.4	3.5	3.5	2.2	3.3	2.7	2.2	3.5	3.1
	USACE 9	3.9	3.9	3.9	2.7	3.2	2.9	2.7	3.9	3.4
Des Allemandes/ Bayou Gauche	USACE 46	2.0	2.1	2.1	0.6	1.7	1.2	0.6	2.1	1.6
	USACE 32	0.9	1.3	1.1	0.5	0.9	0.7	0.5	1.3	0.9
	USACE 33	0.2	0.3	0.2	0.2	0.7	0.5	0.2	0.7	0.4
Grand Bayou	USACE 24	2.8	3.8	3.3	1.2	2.3	1.7	1.2	3.8	2.5
NOV	USACE 26	3.3	3.9	3.6	0.8	2.8	1.8	0.8	3.9	2.7
	USACE 27	2.2	3.4	2.8	0.4	2.2	1.3	0.4	3.4	2.1
	USACE 28	3.2	3.6	3.4	0.4	2.6	1.5	0.4	3.6	2.4
	USACE 29	3.6	3.8	3.7	0.4	2.8	1.6	0.4	3.8	2.6
	USACE 30	2.3	2.4	2.4	0.4	1.5	1.0	0.4	2.4	1.7
	USACE 31	2.2	3.0	2.6	0.4	1.9	1.2	0.4	3.0	1.9
NOV-NFL	Arcadis 1	1.6	1.9	1.8	1.0	1.0	1.0	1.0	1.9	1.5
	Arcadis 2	2.1	3.0	2.6	1.5	1.5	1.5	1.5	3.0	2.2
	Arcadis 3	2.6	3.1	2.8	1.9	1.9	1.9	1.9	3.1	2.5
	Arcadis 4	3.9	4.4	4.2	3.1	3.1	3.1	3.1	4.4	3.8
	Arcadis 5	3.3	3.9	3.6	2.6	2.6	2.6	2.6	3.9	3.3
	Arcadis 6	4.0	4.7	4.3	3.2	3.2	3.2	3.2	4.7	4.0
	Arcadis 7	3.2	3.8	3.5	2.5	2.5	2.5	2.5	3.8	3.2
	Arcadis 9	2.5	3.1	2.8	0.2	1.9	1.1	0.2	3.1	1.9
	Arcadis 10	2.9	3.6	3.3	0.8	2.1	1.5	0.8	3.6	2.4
Lafitte	Arcadis 8	2.8	2.9	2.8	1.9	1.9	1.9	1.9	2.9	2.5

4.0 DESIGN AND OPERATIONAL ANALYSES

The following scenarios were modeled to further analyze the impact to water levels under various design and operational scenarios that could be applicable regardless of which action alternative is selected.

4.1 Open and Closed Conveyance Channel

This scenario was modeled to understand how storm surge would impact water levels inside the conveyance channel. The open-channel scenario was compared to the base scenario, and no changes to peak surge levels or wave heights were found except within the conveyance channel itself (see Figures 4-1 through 4-2). These results were consistent for both 2040 and 2070 conditions.

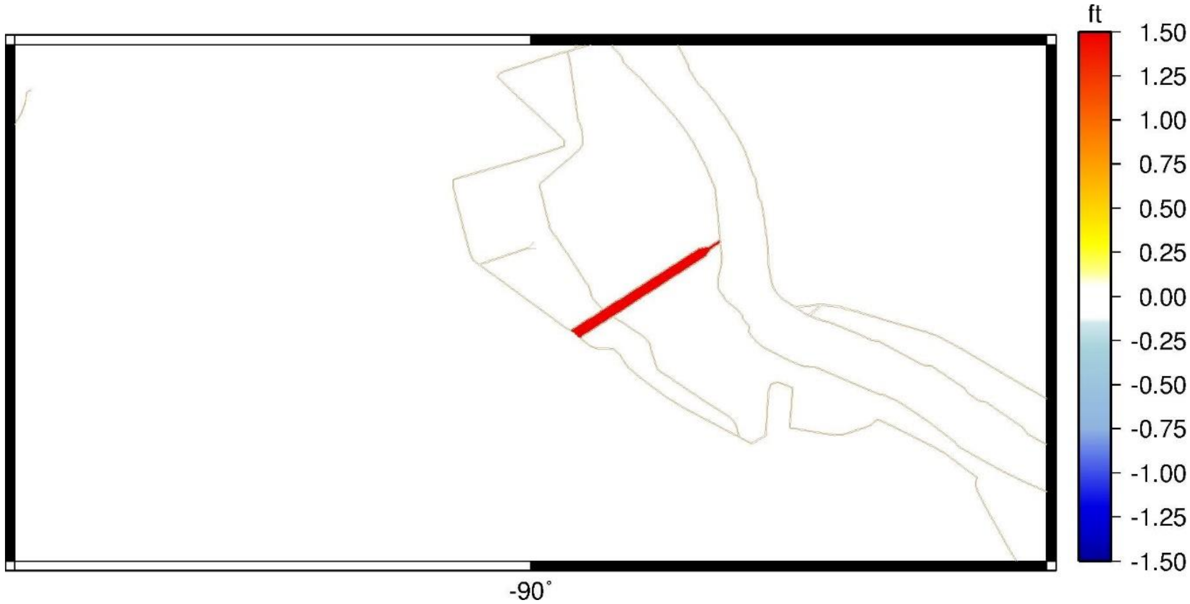


Figure 4-1. Change in Peak Water Levels During 1 Percent AEP Storm (Storm 009): 2070 Applicant's Preferred Alternative + Open Conveyance Channel Less 2070 Applicant's Preferred Alternative.

Figure 4-2. Change in Peak Wave Heights During 1 Percent AEP Storm (Storm 009): 2070 Applicant's Preferred Alternative + Open Conveyance Channel Less 2070 Applicant's Preferred Alternative.

4.2 Diversion Flow Rate Effects

While CPRA intends to cease operation of the diversion in adequate advance of a storm event such that water levels in the Barataria Basin would return to baseline conditions prior to the onset of storm surge and wave impacts, a scenario was modeled to determine how keeping the diversion operational during a storm event would influence water levels. Allowing flow through the diversion pre-storm resulted in higher water levels throughout Barataria Basin during the simulated storm events. Additionally, keeping the diversion open, either fully or partially, during the storm led to additional water volumes in the basin during the event. Accordingly, higher pre-storm water levels and flows entering the basin during a storm translated to higher peak water levels and waves in Barataria Basin during storm events. Figure 4-3 shows the impact of leaving the diversion partially open (Applicant's Preferred Alternative, Partially Open Conveyance Channel) relative to keeping it closed (Applicant's Preferred Alternative) during a 1 percent AEP storm. Figure 4-4 shows the impact of leaving the diversion completely open (Applicant's Preferred Alternative, Completely Open Conveyance Channel) relative to keeping it closed (Applicant's Preferred Alternative) during a 4 percent AEP storm.

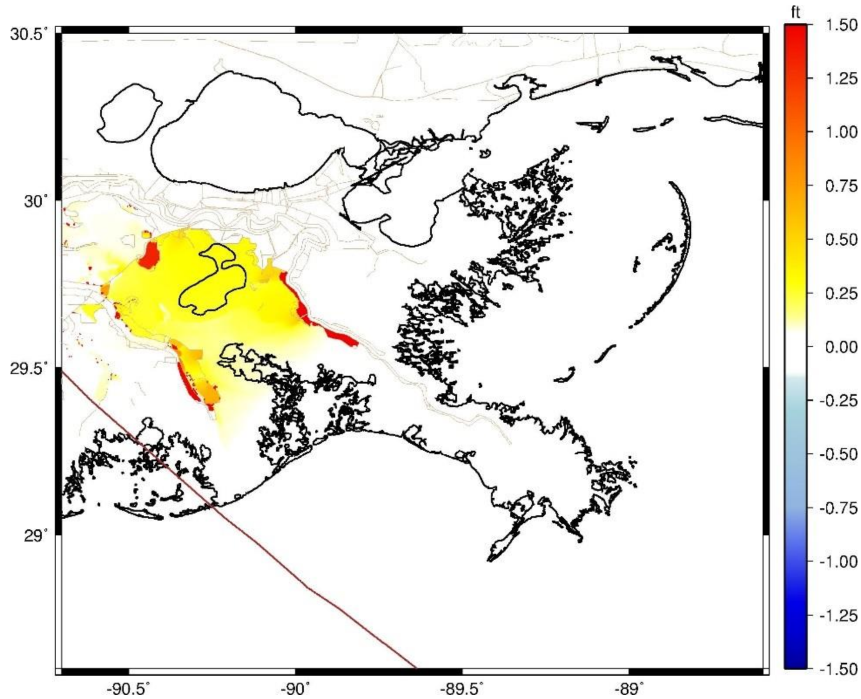


Figure 4-3. Peak water level difference for 2040 Applicant's Preferred Alternative Partially Open less 2040 Applicant's Preferred Alternative during 1 percent AEP event (Storm 093) in September water level conditions.

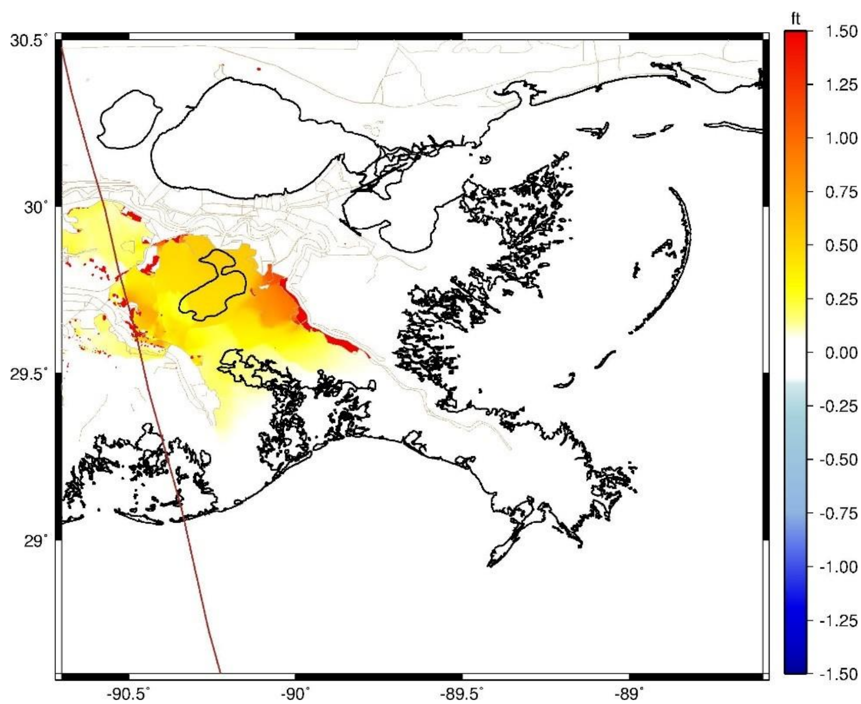


Figure 4-4. Peak water level difference for 2040 Applicant's Preferred Alternative Completely Open less 2040 Applicant's Preferred Alternative during 4 percent AEP event (Storm 011) in June water level conditions.

5.0 REFERENCES

Arcadis. 2019. Mid-Barataria Sediment Diversion – Surge and Wave Conditions Utilizing the Hysteresis Sediment Rating Curve. CPRA. May 17, 2019.

Booij, N., Ris, R. C., and Holthuijsen, L. H. 1999. A third-generation wave model for coastal regions: 1. Model description and validation. Journal of Geophysical Research, 104 (C4), 7649–7666.

CPRA. 2017. 2017 Coastal Master Plan. June 2. http://coastal.la.gov/wp-content/uploads/2017/04/2017- Coastal-Master-Plan_Web-Book_CFinal-with-Effective-Date-06092017.pdf

Flather, R. A.. 1988. A numerical model investigation of tides and diurnal-period continental shelf waves along Vancouver Island. J. Phys. Oceanogr., 18, 115–139.

Hagen, S.C., J.J. Westerink, R.L. Kolar, and O. Horstman. 2001. Two-dimensional, unstructured mesh generation for tidal models, *International Journal for Numerical Methods in Fluids*, vol. 35, 669-686.

Holthuijsen, L.H., A. Hemran and N. Booij. 2003. “Phase-decoupled Refraction-Diffraction for Spectral Wave Models”. Coastal Engineering 49:291-305.

Kolar, R.L., W.G. Gray, J.J. Westerink and R.A. Luettich, Jr. 1994. Shallow water modeling in spherical coordinates: equation formulation, numerical implementation, and application, *Journal of Hydraulic Research*, 32(1):3-24.

Luettich, R.A., Jr., S. Hu, J.J. Westerink, and N.W. Scheffner. 1992. Modeling 3-D Circulation Using Computations for the Western North Atlantic and Gulf of Mexico, Estuarine and Coastal Modeling II, M. Spaulding [ed.], ASCE, pp.632-643.

Ris, R.C., Holthuijsen, L.H. and Booij, N. 1999. A third-generation wave model for coastal regions: 2. Verification. Journal of Geophysical Research 104: doi: 10.1029/1998JC900123. issn: 0148-0227.

Roberts, H. and Z. Cobell. 2016. 2017 Coastal Master Plan: C3-25.1 – Storm Surge and Risk Assessment Appendices. Version II. pp. 61-64. Baton Rouge, Louisiana: Coastal Protection and Restoration Authority.

USACE. 2008a. “Flood Insurance Study: Southeastern Parishes, Louisiana - Intermediate Submission 2.” New Orleans District, Mississippi Valley Division. July.

USACE. 2008b. “Flood Insurance Study: Southwestern Parishes, Louisiana - Intermediate Submission 2.” New Orleans District, Mississippi Valley Division. October.

Westerink, J.J., J.C. Muccino and R.A. Luettich. 1992. Tide and storm surge computations for the Western North Atlantic and Gulf of Mexico, Estuarine and Coastal Modeling II, M. Spauling [ed]., ASCE, New York, N.Y..

Westerink, J.J., R.A. Luettich, Jr., J.C. Feyen, J.H. Atkinson, C. Dawson, M.D. Powell, J.P. Dunion, H.J. Roberts, E.J. Kubatko, H. Pourtaheri. 2008. A Basin to Channel Scale Unstructured Grid Hurricane Storm Surge Model as Implemented for Southern Louisiana, Monthly Weather Review, Volume 136, 833-864.

White, Eric & Meselhe, Ehab & J. Reed, Denise. 2017. “2017 Coastal Master Plan - Appendix C Modeling: Chapter 2 - Future Scenarios.” https://www.researchgate.net/publication/328781002_2017_Coastal_Master_Plan_-_Appendix_C_Modeling_Chapter_2_-_Future_Scenarios

P2: Coastal Water Surface Elevations Report

THE WATER INSTITUTE
OF THE GULF™

ANALYSIS OF EXISTING AND FUTURE POTENTIAL COASTAL WATER SURFACE ELEVATIONS IN BARATARIA BASIN

IN SUPPORT OF THE MID-BARATARIA SEDIMENT DIVERSION EIS IMPACT ANALYSIS

May 2019

To: Joseph Wes Leblanc – PM; Coastal Protection and Restoration Authority (CPRA)

From: The Water Institute of the Gulf:
Martijn Bregman, Francesca Messina, Brendan Yuill, Lauren Grimley, Hugh Roberts

Jacobs:
Guerry Holm, Raffaele Marino

Date: May 17, 2019

Re: Mid-Barataria Sediment Diversion Coastal Water Surface Elevation Analysis

Executive Summary

The analysis within summarizes the potential impacts of the proposed Mid-Barataria Sediment Diversion (MBSD) on coastal water surface elevations (WSE)[1] near select communities within Barataria Basin. Though nuisance flooding can be a result of various factors (e.g., rainfall and tide levels), high coastal water levels (due to a combination of tides, winds, and freshwater inflow) are the focus of this analysis. This report discusses the results of a coastal WSE threshold analysis completed for Lafitte, Myrtle Grove, and Grand Bayou, including the impacts on threshold exceedance frequencies for each community due to inflows into the basin from the MBSD, eustatic sea-level rise (ESLR) and subsidence. The analysis was

[1] Coastal water surface elevation (WSE) is the level that the sea surface (at a given point and time) would assume in the absence of wind waves. For this analysis, WSEs are a combination of tides, winds, and freshwater inflows. The terms WSE and water level are used interchangeably in this document.

developed to assist the USACE (U.S. Army Corps of Engineers) evaluate the potential effects of the MBSD and a range of alternatives, including no action, on current and potential future coastal WSEs.

The analysis centers around the comparison of modeled coastal WSEs and elevation thresholds selected for each community. The thresholds selected for each community were determined using LiDAR data, flood maps, and direct observation by CPRA to establish an approximate elevation when inundation typically occurs in each community today. A historical analysis of measured WSE data was used to determine the frequency of threshold exceedance at each community. From 2008 to 2017, Myrtle Grove experienced an average of 9 to 10 days per year when the WSE threshold was exceeded whereas Lafitte experienced an average of 1 day per year when the WSE threshold was exceeded. From 2007 to 2017, Grand Bayou experienced an average of 7 days per year when the WSE threshold was exceeded.

This analysis utilized model outputs from a series of 50-year simulations performed using the Delft3D Basinwide model Version 3 (V3) to project the landscape evolution of the Mississippi River delta area. The simulations used for this coastal WSE threshold analysis were developed and run to support the MBSD Environmental Impact Statement (EIS). The analysis includes ESLR modeled according to the moderate scenario as defined in the 2017 Coastal Master Plan (Meselhe, White, and Reed 2017), subsidence and various historic Mississippi River hydrographs within the model setup. The combined effects of ESLR and subsidence, referred to as relative sea-level rise (RSLR), are variable in time and space in the model, with values in 2070 ranging from 2.9 – 3.34 ft (relative to 2020) for the three communities.

The scenarios investigated include the Future without Project (FWOP), or the without diversion scenario, and the Future with Project (FWP) when the diversion is opened when the river discharge exceeds 450,000 cubic feet per second (cfs). The maximum discharge capacities for the three alternatives under consideration are 50,000, 75,000, and 150,000 cfs when the Mississippi River discharge reaches or exceeds 1 million cfs. This report focuses on comparing the results of the Applicant Preferred Alternative with a discharge capacity of 75,000 cfs (referred to as 75k cfs) relative to the FWOP in the short, medium, and long-term. Results for other alternatives (50k cfs and 150k cfs) are included in Appendix C.

The increase in WSE over the 50-year FWOP simulations, due to RSLR, is summarized for each community using a metric of calendar days with WSEs exceeding the selected threshold elevations. In the FWOP, Myrtle Grove is predicted to experience threshold exceedance over 60 days annually in the short-term (2020s), 60-85% of the days in the mid-term (2040s), and nearly every day in the long-term (2060s). Threshold exceedances near Lafitte are predicted to be limited to episodic storm events in the near term (2020s and 2030s), occur 50 or more days annually in the medium-term (2040s) and nearly daily in the long-term (2060s). Grand Bayou, similar to Myrtle Grove, is predicted to be vulnerable to coastal WSEs above the exceedance threshold over 60 days annually in the near-term (2020s), nearly 80% of the days (~300 days annually) in the mid-term (2040s), and have WSEs exceeding the threshold daily, independent of the season, by the long-term (2060s).

To compare FWOP and FWP conditions, the analysis focuses on comparison of the instantaneous water levels, average monthly water levels, and the number of days of threshold exceedance at discrete locations near each of the three communities. Results vary by community based on proximity to the diversion and the exceedance threshold defined for each, though some themes are consistent throughout and summarized in the key conclusions below.

Additionally, a spatial analysis was completed to compare average water level difference between the FWOP and FWP conditions for a week that the diversion is operating at full capacity. The comparison shows the maximum increase in average WSE due to the MBSD is 2 to 3 ft immediately adjacent to the diversion and on the order of 0.5 to 1 ft near Lafitte and Grand Bayou. Additional spatial analysis to compare peak high-water levels for FWOP and FWP conditions during simulated storm events demonstrated that WSE increases associated with the operation of the diversion during storm events were generally 1 ft or less throughout the basin including immediately adjacent to the diversion.

Key conclusions based on the comparison of the FWP Applicant Preferred Alternative and the FWOP simulations are as follows:

- In the short-term (2020s), the diversion is predicted to increase the water level up to 1.3 ft near Myrtle Grove which would cause the annual WSE threshold exceedances to triple. The water level near Lafitte is not significantly impacted by the diversion, increasing up to 0.3 ft with minimal additional threshold exceedances. The FWP water levels near Grand Bayou are predicted to increase up to 0.5 ft resulting in a doubling of annual threshold exceedances. The diversion impacts on WSE threshold exceedances are most substantial in the short term at Myrtle Grove and Grand Bayou.
- In the medium-term (2040s), the diversion is predicted to increase WSEs by up to 0.9 ft near Myrtle Grove and less substantially near Lafitte (0.3 ft) and Grand Bayou (0.3 ft). However, by the 2040s, both Myrtle Grove and Grand Bayou experience frequent threshold exceedance with and without the presence of the MBSD. Lafitte experiences a lower frequency of threshold exceedance than the other two communities, making the area most sensitive to diversion operations in the 2040s and 2050s. Due to diversion related WSE increases on the order of tenths of a foot on average, an additional 15 days of threshold exceedance could be expected annually in Lafitte in the 2040s and closer to 30 days annually in the 2050s.
- In the long-term (2060s), RSLR is predicted to be the dominant factor in increased water levels near the communities. Though the model simulations demonstrate an increase in water level in the area because of the MBSD, the thresholds are exceeded frequently for each community (over 280 days annually for Lafitte and nearly daily near Myrtle Grove and Grand Bayou) regardless of the operation of the diversion.

Introduction

Across the Louisiana coast, many communities are at risk to nuisance flooding associated with high-water levels. Predictions show that there will be an increase in WSEs largely due to the combined effects of ESLR and subsidence. This report explains the potential effects of the proposed MBSD on coastal WSEs adjacent to nearby communities.

This report was generated using the results from the second set of the production runs (also named as HYST production runs – see Appendix B) performed for the to support the MBSD EIS by using the Delft3D Basinwide V3 model (Sadid et al. 2018). Modeled water surface elevations both with and without the MBSD are compared to WSE thresholds to determine the degree to which the MBSD may affect WSE threshold exceedance in three nearby communities, Myrtle Grove, Lafitte, and Grand Bayou. Through this comparison, this report explains the anticipated frequency of exceedance for a range of projected future conditions both with and without the MBSD.

The modeled results are based on Delft3D Basinwide V3 model runs (Sadid et al. 2018), which includes a range of compounding effects that impact coastal WSEs including tides, precipitation in the basin, wind, ESLR, and subsidence. The analysis focuses on the coastal WSEs immediately adjacent to the communities but does not evaluate the concomitant effects of precipitation and local drainage within protected areas of the communities. Additionally, the impacts the diversion may have on future tropical storm surge elevations and wave conditions are summarized in a separate document outlining an ADCIRC and SWAN based modeling effort (Arcadis, 2019).

The WSE threshold exceedance analysis was completed for historic conditions, FWOP, and FWP. For historic conditions, gauge measurements were used to determine the frequency of WSEs exceeding the threshold over the past decade to assess the existing conditions. For future conditions, the predicted WSEs were simulated for both FWP and FWOP scenarios, and the high-water levels were analyzed relative to the WSE exceedance thresholds defined for each community. The changes in threshold exceedance related to ESLR and subsidence can be understood by comparing historic conditions and FWOP, while project related impacts can be examined by comparing FWOP and FWP outputs.

In this report, the community locations and selection of the WSE exceedance threshold are discussed. The historic conditions of WSE patterns at each community is presented to frame the discussion on future conditions. The methodology and results of the future conditions analysis is presented including a comparison of the three diversion capacity alternatives (50k, 75k, and 150k cfs discharge). All three FWP alternatives are compared to FWOP and a summary of the monthly average water level variation induced by the diversion is presented, with a focus on the Applicant Preferred Alternative (75k cfs). The spatial patterns of the weekly average water levels and instantaneous peak WSEs for the Applicant Preferred Alternative of 75k cfs capacity are presented. Lastly, to better understand the sensitivity of threshold exceedance frequency to subsidence and variations in the Mississippi River discharge, additional analyses were conducted.

Study Area

The Delft3D Basinwide V3 model domain includes the lower part of the Mississippi River, Barataria Basin, Breton Sound Basin, and a small part of the Gulf of Mexico. The grid resolution varies between 125 meters in Barataria Basin and Breton Sound Basin and 4.5 kilometers in the Gulf of Mexico. Detailed information about the model can be found in Sadid et al. (2018).

As part of FWP and FWOP model simulations, WSE time series are outputted across the model domain. The analysis presented focuses specifically on areas in Barataria Basin where the modeled diversion operations result in changes in WSEs compared to FWOP model results. Additional community-specific analyses were completed as described below.

COMMUNITY LOCATIONS

The three focus communities (Lafitte, Myrtle Grove, and Grand Bayou) are located within 20 miles of area of the proposed MBSD and outside of levee protection. The Lafitte area is complex with varying population density, ground elevations, structure elevations, levels of flood protection, and drainage system capacity. The Myrtle Grove area (including Woodpark) is near the basin side (outside levee protection) of the Plaquemines Parish non-federal back levee and comprises a marina, residences, recreational homes and camps in Plaquemines Parish. Grand Bayou is a wetland and water-based Native American village outside of levee flood protection.

Existing Coastwide Reference Monitoring Systems (CRMS) gauge locations have been used as representative locations to assess threshold exceedance of water surface elevations for each community. Gauge locations are used so that model outputs can be compared to historical measurements. Each gauge was selected due to its proximity to the communities. The MBSD diversion outfall, three communities and the gauge locations are shown in Figure 1. Figure 1 also shows the location of station HWO08. This station has been used for part of the analysis presented in this report (see "Future with Project" section) because it is the closest model output station to the diversion outfall channel (less than 4 miles).

For Lafitte and Myrtle Grove, the CRMS4245 and CRMS0276 stations, respectively, were evaluated. For Grand Bayou, the station data used for the historic analysis included both CRMS0282 and CRMS3680. While CRMS0282 is geographically closer to Grand Bayou, the data time series for that station is incomplete. Hence, CRMS3680 is included in the analysis because the timeseries for this station is more comprehensive. All the analyses of model output are based on station CRMS0282.

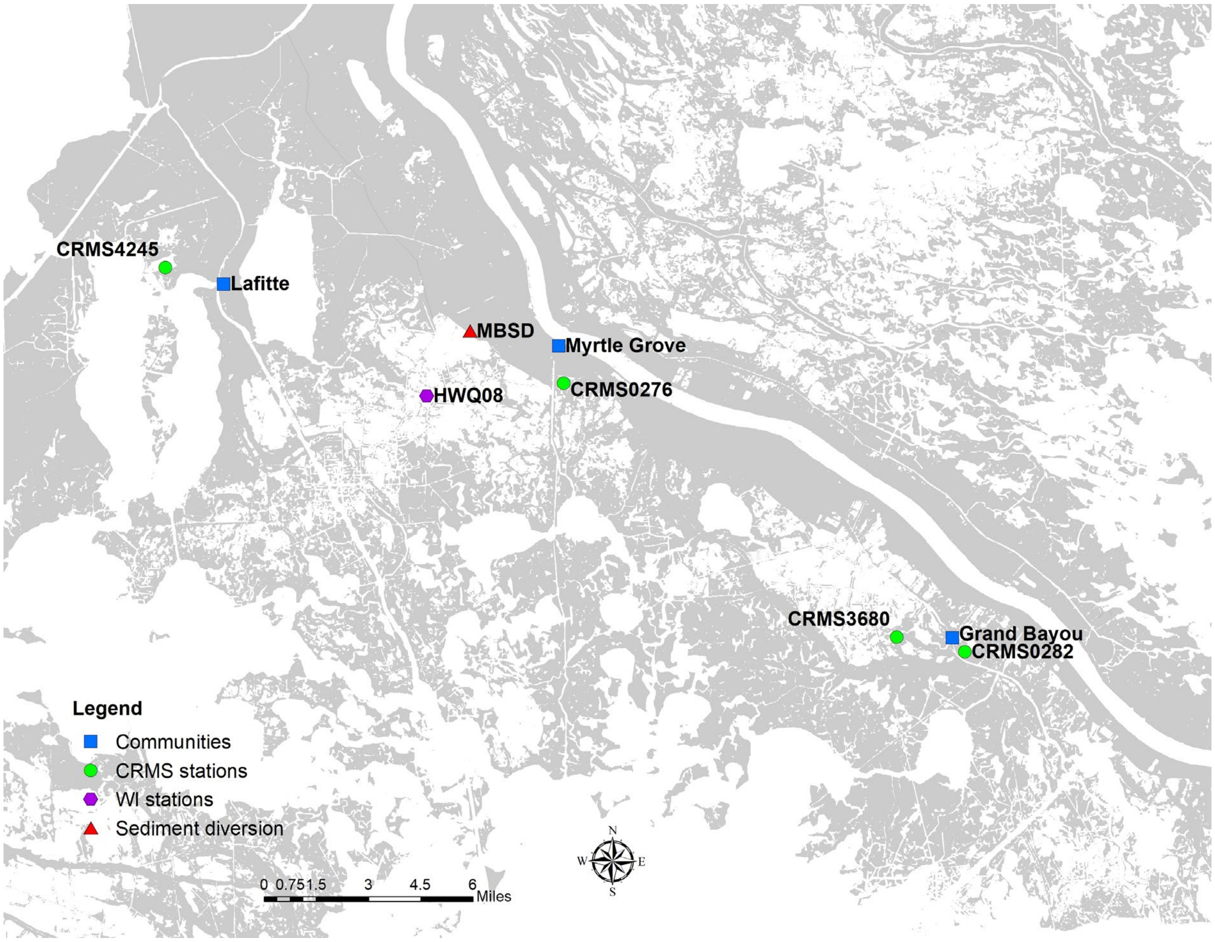


Figure 1. The location of the sediment diversion project (MBSD), communities, CRMS gauge locations, and The Water Institute (WI) model output station used in the analysis.

Threshold Elevations

To frame potential sensitivities to WSEs for each community, threshold water surfaces elevations (referred to as WSE thresholds) were established for each community for this analysis. The Coastal Protection and Restoration Authority (CPRA) used published LiDAR data, recent flood mapping products (NOAA, Coastal Flood Exposure Mapper, https://coast.noaa.gov/floodexposure) and published literature (NOAA, 2018) to select gauge elevation thresholds that are indicative—today—of the lowest elevation where inundation commences. These WSE thresholds are intended to be conservative, and are most useful for recent and near-term conclusions, given the rapid subsidence in the study area and tidal protection projects at Lafitte. In this analysis, these WSE thresholds are used to determine the frequency of threshold exceedance for both historic and future scenarios including adjustment of the thresholds over time to consider subsidence.

The Lafitte area includes ten separate basins, each of which has varying levels of flood protection and are at different phases of planning, design, and construction. To simplify analysis results, a conservative threshold, representing the lower elevation of inhabited ground elevations was selected. The WSE threshold for this analysis was set at +2.5 ft NAVD88, which was derived from a combination of CPRA project planning and ground elevation surveys for the design of tidal protection basins summarized in Table 1. Supporting material are included in Appendix A (Figure A 5.1 and Figure A 5.2). The 2.5 ft threshold for Lafitte corresponds well with NOAA's minor flooding threshold guidance (Sweet et al. 2018) for this area. The Great Diurnal Range (GT= Mean Higher High Water (MHHW) – Mean Lower Low Water (MLLW)) at Lafitte is estimated to be approximately 0.3 meters and the minor flood threshold calculated according to the NOAA's guidance is 0.8 meters above MLLW (Figure A 1). The conversion from the local tidal datum (MLLW) and geodetic datum (NAVD88) is estimated to be approximately -0.10m ± 0.10 m and so the minor flood threshold is within the range 0.7 m ± 0.1 m (2.3 feet ± 0.3 feet) above NAVD88[2] datum.

For the Myrtle Grove area, the WSE threshold was set at 1.75 ft NAVD88, which was initially based on local information obtained by CPRA from the community and later confirmed with ground elevation surveys in the development (Figure A 2). Recent wind tide events that exceed 1.7-1.8 ft have demonstrated that the threshold selected is appropriate and consistent with direct observation[3], ground survey, and gauge data (Figure A 3). LiDAR data confirmed that once high-water levels occur above approximately 2.0 ft NAVD88, the development access roads are generally flooded (Figure A 2). Main access and lateral slip roads generally slope from +2.0 to +0.6 ft NAVD88 to allow water to drain from the lots and into the surrounding polder and the drainage of water from the development to the adjacent polder, and then to Wilkinson Canal pump station, is not sufficient to manage flooding induced by high-water levels. Also, within the Myrtle Grove area, the surrounding wetland elevation is generally +0.7 to

---

[2] All NAVD88 elevations used in this report reference Geoid12A

[3] Apr 8, 2019: CPRA (Barth, B.) visited Myrtle Grove during strong onshore winds and observed inundation across the community. Observations were corroborated by All South Consulting Engineers with previous survey data and adjacent water gage data at CRMS 0276 (see Peak 1, Appendix Figure A 3).

0.8 ft NAVD88 (CRMS 0276). A WSE of 1.0 ft or more above the wetland elevation corresponds with the onset of inundation.

For the Grand Bayou area, the WSE threshold was set at +1.5 ft NAVD88, which was based on both LiDAR data and wetland elevation. Wetland elevation in this area is approximately +0.5 ft NAVD88 (Source: CRMS Station 0282/3680). Similar to Myrtle Grove, WSEs at +1.0 ft above wetland elevation corresponds with the onset of inundation. This assumption is further supported by LiDAR data (Figure A 4), which shows ground elevations in the range +0 to +2 ft NAVD88.

Table 1 lists the data used to select the WSE threshold for the three communities in this analysis. It should be noted that these WSE thresholds were established based on the limited data, tools, and resources described herein. These thresholds could be revised based on additional or more detailed data and analysis, such as:

- identify low-lying area within the study area (using for example the latest LiDAR data);
- identify current and future level of flood protection for the three communities (including tidal protection projects at Lafitte); and
- assess the potential impact of rising water levels within each community, including producing inundation maps for each study area.

Table 1: Summary data for the selected gauge locations and WSE threshold selection for nearby communities

Reference Gauge	Relevant Communities	WSE Threshold (ft NAVD88 12A)	Type of Protection against high WSEs	Federal Emergency Management Agency (FEMA) Information (Figure A 6 and Figure A 7)*	Supporting Sources of Information for Threshold Selection
CRMS4245	Lafitte area basins	2.5	Varying levels of tidal protection among basins	**Jefferson Parish FIRM effective Feb 2018** ***Jean Lafitte*** (Zone AE - High Risk Areas) Base Flood Elevation (BFE) = 8 ft ***Lafitte*** (Zone AE - High Risk Areas) FEMA Base Flood Elevation (BFE) = 9 ft	• NOAA minor tidal flooding threshold elevation (Figure A 1) • Rosethorne basin guidance (Brown Cunningham Gannuch 2002). Jean Lafitte tidal protection basin (CPRA Board Meeting, 2018) • Representative ground elevation data from Jean Lafitte basin design for tidal protection (Figure A 5.1) • LiDAR data (Figure A 5.2)
CRMS 0276	Myrtle Grove	1.75	Unprotected	**Plaquemines Parish Preliminary Firm** ***Myrtle Grove Area*** (Zone VE - High Risk - Coastal Areas) FEMA Base Flood Elevation BFE = 11-14 ft	• CPRA ground elevation survey 2017 • Direct observation coupled with gauge data (Figure A 3) • LiDAR (Figure A 2)
CRMS0282 or CRMS3680	Grand Bayou	1.5	Unprotected	**Plaquemines Parish Preliminary Firm** ***Grand Bayou Area*** (Zone VE High Risk - Coastal Areas) FEMA Base Flood Elevation BFE = 13 ft	• LiDAR (Figure A 4) • Wetland elevations (CRMS Station 0282/3680)

Threshold Exceedance and Project Impact Analysis

A threshold exceedance analysis has been conducted to assess the frequency and duration that WSEs exceed the threshold elevations described in the previous section for each community. The analysis includes the assessment of historic conditions, FWOP, and FWP.

The historic conditions assessment was completed using CRMS gauge data to determine the current expected exceedance frequency and duration at the three communities based on measured data. The historic conditions assessment is used to define a current condition to compare against.

The FWOP analysis is based on modeled results from the Delft3D Basinwide V3 model. The methodology, calibration, and validation of this model is discussed in the Future Conditions section below and Appendix B. The model was used to perform a 50-year analysis without the MBSD, including consideration of ESLR and subsidence. Note that all reported water levels in the model are relative to the existing NAV88 Geoid12A vertical datum and that model simulations account for ESLR and subsidence separately in the model setup. ESLR increases coastal WSEs over time, while subsidence lowers the elevation in the model bathymetry and topography. Accordingly, the land elevation for communities will subside with time and the threshold elevations described in the previous section should also lower in time coincident with subsidence rates. However, unless otherwise noted, threshold elevations are held constant over time in the analysis and therefore the reported threshold exceedance frequencies based on comparison to a fixed threshold are likely to be underestimated over the long term as subsidence continues.

Similar to FWOP, the FWP analyses are based on a 50-year analysis using the Delft3D Basinwide V3 model. A comparison between the Applicant Preferred Alternative (i.e., 75k cfs capacity) and the FWOP on threshold exceedance and WSEs is highlighted and presented in this report. The results for the 50k and 150k cfs MBSD capacity are presented and discussed briefly in Appendix C.

HISTORIC CONDITIONS

The results of the frequency analysis of WSEs measured near the three communities are presented here to provide a background on the historical state of tidally and wind driven WSEs in the area. The threshold exceedance frequencies and related information for the three communities are presented in Table 2. Using the thresholds described in the previous section, the analysis of the measured data at the gauge locations yields a threshold exceeded of 9 to 10 days per year for Myrtle Grove in the years between 2008-2017. The frequency of threshold exceedance for Grand Bayou between 2007-2017 is slightly lower at 6 to 7 days. The water level measured at Lafitte only exceeded the threshold an average of 1 day per year between 2008-2017. For all three communities, the duration that the measured data at the gauge exceeded the threshold typically varies from several hours up to 3 days.

Table 2: WSE statistics based on historic water level data for Myrtle Grove, Lafitte, and Grand Bayou.

Community and Gage	Myrtle Grove (CRMS 0276)	Lafitte (CRMS4245)	Grand Bayou (CRMS0282)	Grand Bayou (CRMS3680)
Start date	3/13/2008	5/6/2008	9/26/2007	1/29/2008
End date	8/17/2017	7/13/2017	10/28/2017	8/2/2017
Water level threshold (ft NAVD88)	1.75	2.5	1.5	1.5
Record length (years)	9.4	9.2	10.1	9.5
Missing data (years, total length)	1.3	0.6	3.5	0.1
No. of days exceeding threshold	90	9	65	68
Threshold exceedance frequency (days per year)	~9.5	~1	~6.5	~7
Max duration of threshold exceedance (days)	~3.5	~2.5	~2.5	~3
Mean duration of threshold exceedance (days)	~0.5	~1	~0.5	~0.5

FUTURE CONDITIONS

Water surface elevations are expected to increase due to RSLR. Under the present and near-future circumstances, high water levels that exceed the established threshold are usually caused by weather events (e.g., wind, cold fronts, etc.). However, in the longer (decadal) term, RSLR is projected to cause an increase in WSE threshold exceedances at each community. The future WSEs near the communities were modeled with and without MBSD. The simulated WSEs were analyzed to determine the number of threshold exceedances each community is predicted to experience. A summary of the temporal and spatial changes in WSEs at each community is presented to better understand the frequency and duration of WSE threshold exceedance near local communities.

Methodology

The analysis of future conditions WSEs at the communities was modeled using the Basinwide model V3. The methodology, calibration, and validation of this model is discussed in Appendix B. The model was used to perform 50-year simulations with and without MBSD. Different scenarios have been considered including:

- Future without Projects (FWOP, V3PR1): MBSD is not operated;
- Future with Projects (FWP): MBSD is operated when the river discharge exceeds 450,000 cfs and reaches maximum capacity at one million cfs. The maximum MBSD discharge capacities for the three alternatives under consideration are:
    - V3PR2: 50k cfs
    - V3PR4: 75k cfs (note: referred to as the Applicant Preferred Alternative)
    - V3PR6: 150k cfs

The body of this report summarizes results for FWOP and FWP V3PR4. Additional FWP results for the V3PR2 and V3PR6 MBSD alternatives are summarized in Appendix C.

Mississippi River Hydrograph

The morphodynamic simulations cover a continuous 50-year period, divided in 5 decades (also called cycles): 2020-2029 to 2060-2069 (i.e., cycle 0 to 4). Within each of the decade cycles, a single year hydrodynamic simulation was performed to represent the water level conditions of that decade. The Mississippi River hydrographs used in the hydrodynamic simulations are based on historical records. The representative years for each decade have been selected as described in Meselhe et al (2017). An additional sixth hydrodynamic simulation was performed at the end of the 50-year morphology runs to represent the hydrodynamics on the 2070 landscape (cycle 5). In addition to the representative hydrograph for each decade, four additional Mississippi River hydrographs are simulated for each of the six hydrodynamic simulation cycles based on historical records for those years (Figure 2):

- 1994 – high, consistent spring flow (Figure 2A);
- 2006 – low, multiple peak spring flows (Figure 2B);
- 2010 – high, multiple peak spring flow (Figure 2C); and,
- 2011 – late spring high flood flow (Figure 2D).

Since each modeled decade includes simulations of the year-long 1994, 2006, 2010 and 2011 Mississippi River hydrographs, water levels can be compared across decades based on outputs for any of these four annual simulations. For the purposes of this analysis, the 2011 Mississippi River hydrograph has been considered to compare across decades and between FWOP and FWP because it represents a high flow year, when the MBSD would be in operation at maximum capacity for a long period of time.

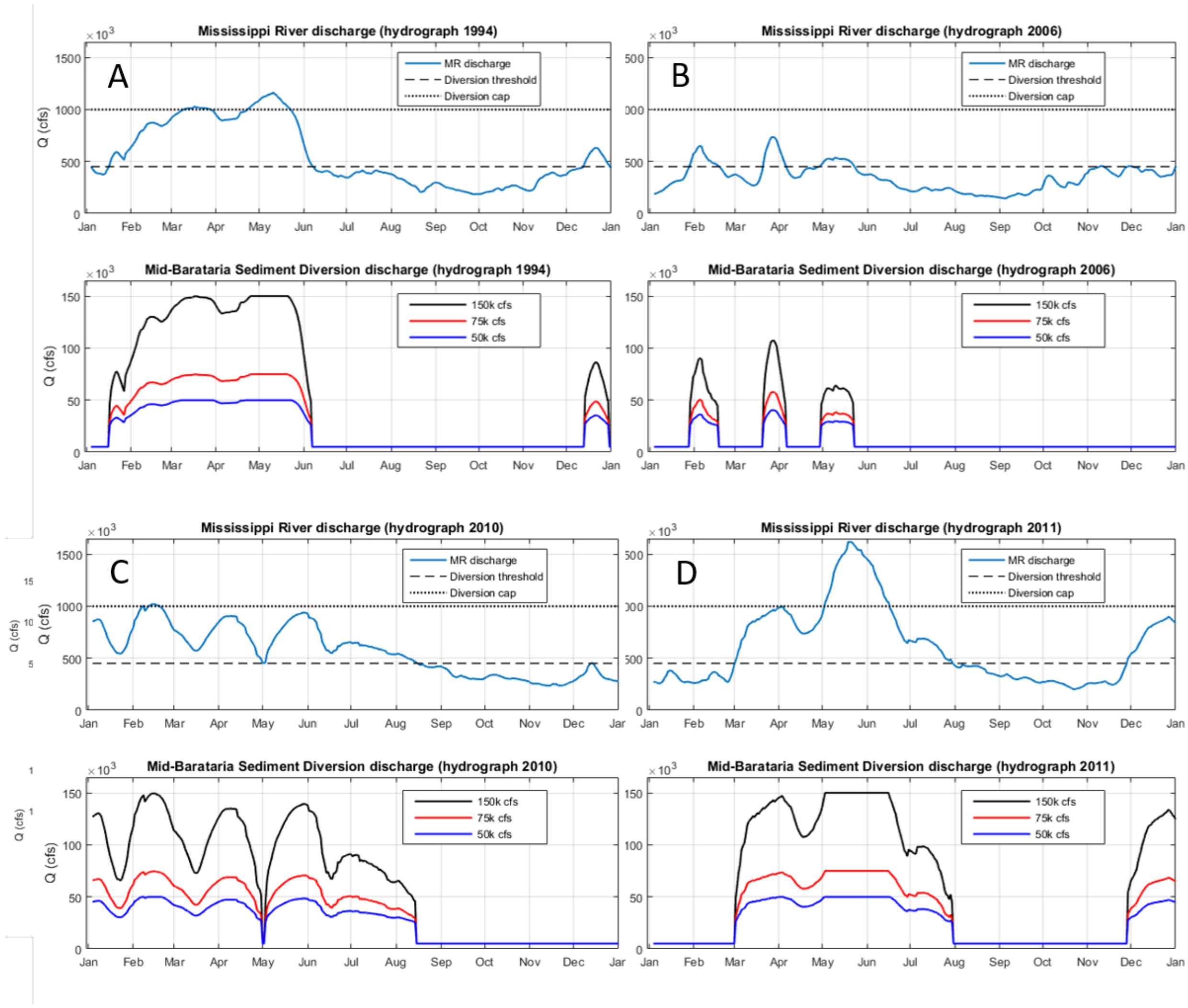


Figure 2: Mississippi River hydrographs (top of each graphs) and MBSD discharge for the 50k, 75k and 150k cfs diversion capacities (bottom of each graph) for 1994 (A), 2006 (B), 2010 (C), and 2011 (D)

The 2011 hydrograph represents a large and extended duration of high Mississippi River discharge which would result in the operation of the diversion at full capacity for a relatively long-lasting period from March to July and December. The conveyed discharge was found to be either at, or close to, the capped maximum discharge during this period. Because the diversion is open for a relatively long period of time during the 2011 Mississippi River conditions, *the duration of increased water levels* (and thus the duration of threshold exceedance in many cases) will be greater for a 2011 Mississippi River discharge condition when compared to other simulated years (i.e., 2006). However, on the condition that the capped diversion discharge is reached in a given simulated year, *the maximum water level increase* induced by the diversion did not vary significantly between different annual Mississippi River hydrographs.

Sea Level Rise and Subsidence

The analysis within leveraged model outputs from a series of 50-year simulations performed using the Delft3D Basinwide model V3 to simulate the landscape evolution of the Mississippi River delta area. As part of the completed Basinwide V3 simulations, the individual and combined effects of ESLR and subsidence were modeled and capture changes in WSEs throughout the model domain. The ESLR was modeled according to the moderate scenario of 4.9 ft/1.5 m by 2100 according to the 2017 Coastal Master Plan (Meselhe, White, and Reed 2017). During the 50-year simulation period between 2020 and 2070, a total ESLR of 2.2 ft was applied with an acceleration in the rise towards the end of the period, as shown in Figure 3. More detailed information can be found in Table 2.

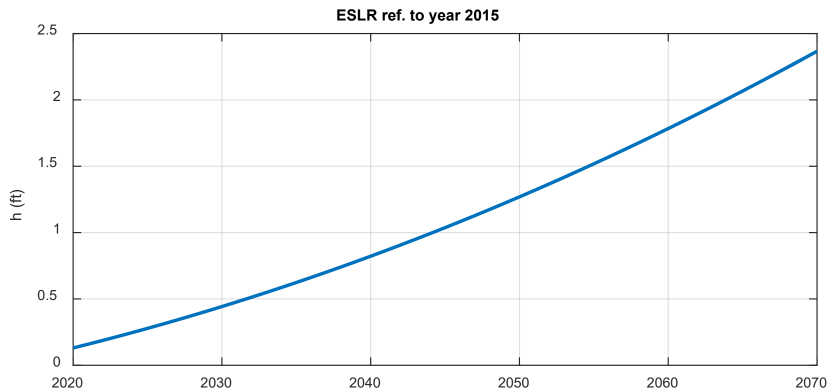


Figure 3: Eustatic Sea Level Rise during the simulation period. h is sea-level elevation relative to year 2015.

Table 3: Applied ESLR relative to year 2015

	Sea-level elevation relative to year 2015		Relative change (decade to decade)	
Year	(m)	(ft)	(m)	(ft)
2020	0.04	0.13	---	----
2030	0.13	0.44	0.10	0.31
2040	0.25	0.82	0.12	0.38
2050	0.39	1.27	0.14	0.45
2060	0.54	1.78	0.16	0.51
2070	0.72	2.37	0.18	0.58

The subsidence rates at each of the communities used in the model domain are shown in Figure 4 (Meselhe, Baustian, and Mead 2015). The trend of the modeled subsidence is linear with a rate of ~0.26 in/yr for Myrtle Grove and Grand Bayou and ~0.10 in/yr for Lafitte. Over the 50-year simulation period, a total subsidence of 1.1 ft for Myrtle Grove and Grand Bayou and 0.7 ft for Lafitte was applied. The relative and cumulative bed level change due to subsidence is provided in Table 4.

To compute the combined effects, subsidence was added to ESLR to compute RSLR. Over the 50-yr simulation period (2020-2070), the RSLR in 2070 ranged from 2.9 – 3.34 ft (relative to 2020) for Lafitte and Myrtle Grove/Grand Bayou, respectively. Based on the conditions considered in this study, RSLR (relative to 2020) is estimated to be between 0.95 and 1.13 feet by 2040 for the three communities considered

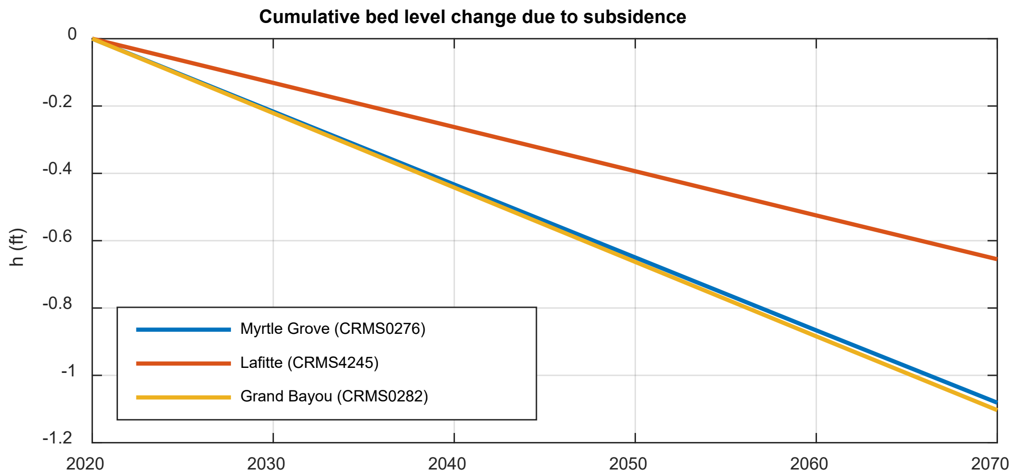


Figure 4: Bed level change applied in the Basinwide model due to subsidence at the three communities where h is ground elevation relative to year 2020.

Table 4: Bed level change due to subsidence

	Relative change (decade to decade)						**Cumulative change (rel. to 2020)**					
	Myrtle Grove		Lafitte		Grand Bayou		Myrtle Grove		Lafitte		Grand Bayou	
Year	(m)	(ft)	(m)	(ft)	(m)	(ft)	(m)	(ft)	(m)	(ft)	(m)	(ft)
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2030	-0.07	-0.22	-0.04	-0.13	-0.07	-0.22	-0.07	-0.22	-0.04	-0.13	-0.07	-0.22
2040	-0.07	-0.22	-0.04	-0.13	-0.07	-0.22	-0.13	-0.43	-0.08	-0.26	-0.13	-0.44
2050	-0.07	-0.22	-0.04	-0.13	-0.07	-0.22	-0.20	-0.65	-0.12	-0.39	-0.20	-0.66
2060	-0.07	-0.22	-0.04	-0.13	-0.07	-0.22	-0.26	-0.87	-0.16	-0.52	-0.27	-0.88
2070	-0.07	-0.22	-0.04	-0.13	-0.07	-0.22	-0.33	-1.08	-0.20	-0.66	-0.34	-1.10

.

Future Without Project

An overview of the FWOP (V3PR1) simulation results over time is presented in this section. The FWOP analysis includes simulation of all decades, 2020 to 2070, incorporating ESLR and subsidence as described previously. The Mississippi River hydrographs used for the 50-year production run include the hydrograph of the representative years of each decade and the Mississippi River hydrographs for 1994, 2006, 2010, and 2011. The results within this section are those results for each decade based on the 2011 Mississippi River hydrograph unless otherwise noted.

Average water surface elevations for each decade and WSE thresholds for each community are shown in Figure 5 to Figure 7[4]. The figures compare the average annual WSEs to the threshold elevations defined for each community. The annual WSE are plotted along with the maximum and minimum monthly averaged WSE (i.e., the highest and lowest monthly averaged WSE in a calendar year) to provide bounds for the range of average levels expected within the basin. The threshold elevations are represented in two ways: as a fixed threshold (as described in the previous Thresholds Elevations section) and as a varying threshold that accounts for projected local subsidence over time. The fixed threshold is included to provide a consistent vertical elevation through the course of time. The variable threshold, adjusted for subsidence, is included because subsidence is accounted for separately from ESLR in the Basinwide V3 model. Because of this, the frequency and duration of threshold exceedance as defined by WSE outputs from the model will be underestimated without adjusting the thresholds over time to consider subsidence.

As shown in Figure 5 and Figure 7, there is a significant difference between the number of days of threshold exceedance in the 2020s and 2030s in Myrtle Grove and Grand Bayou. Accounting for subsidence leads to a notable increase in the total number of days that thresholds are exceeded in the 2020s through 2040s. After the 2040s, subsidence has a less substantial impact due to the high frequency of threshold exceedance with or without considering subsidence in the threshold analysis.

Due to the relatively higher threshold elevation for Lafitte (Figure 6) compared to Myrtle Grove and Grand Bayou, both the frequency of threshold exceedance and the criticality of subsidence in the calculation of threshold exceedance are most prominent in the 2040s to 2060s. Prior to the 2040s, the number of days exceeding the defined threshold elevation are relatively limited. However, after the 2060s, the frequency of exceedance is high regardless of whether subsidence is factored in.

[4] Note that the model has a 3-day spin-up period January 1-3 during which outputs are not saved. Because of this, the maximum possible number of days for threshold exceedance based on model outputs 362 for the calendar year.

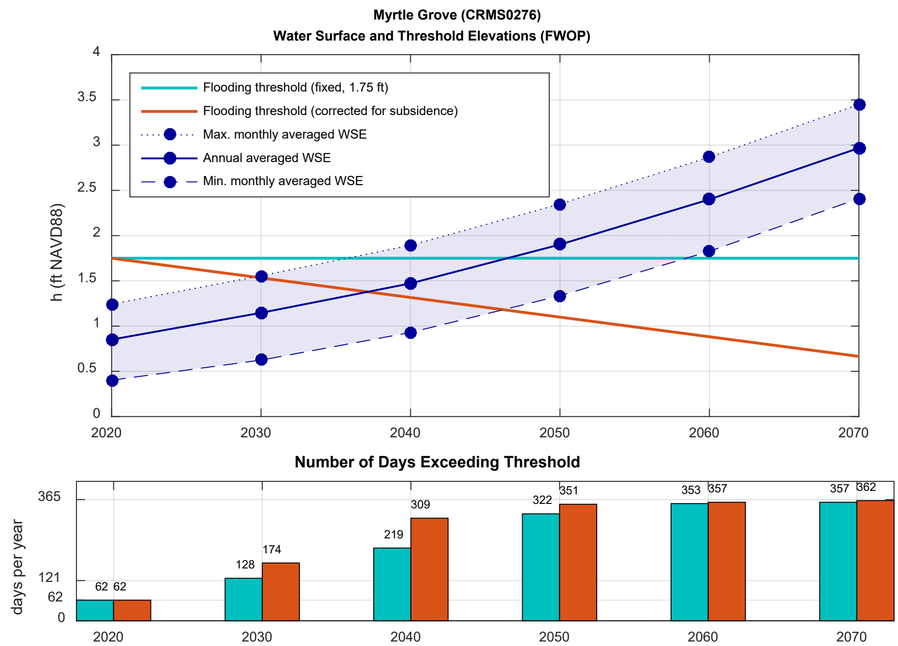


Figure 5: Analysis of the WSE in Myrtle Grove over time, FWOP simulation, 2011 hydrograph. (Top graph) Annual average WSE (blue solid line) and its range of variation (min/max monthly average, blue dotted lines), fixed WSE thresholds (green line) and WSE threshold corrected with subsidence (orange line). (Bottom graph) Annual number of days exceeding the fixed WSE threshold elevation (green) and the corrected threshold elevation (orange). WSE is referenced to NAVD88 (GEOID12A).

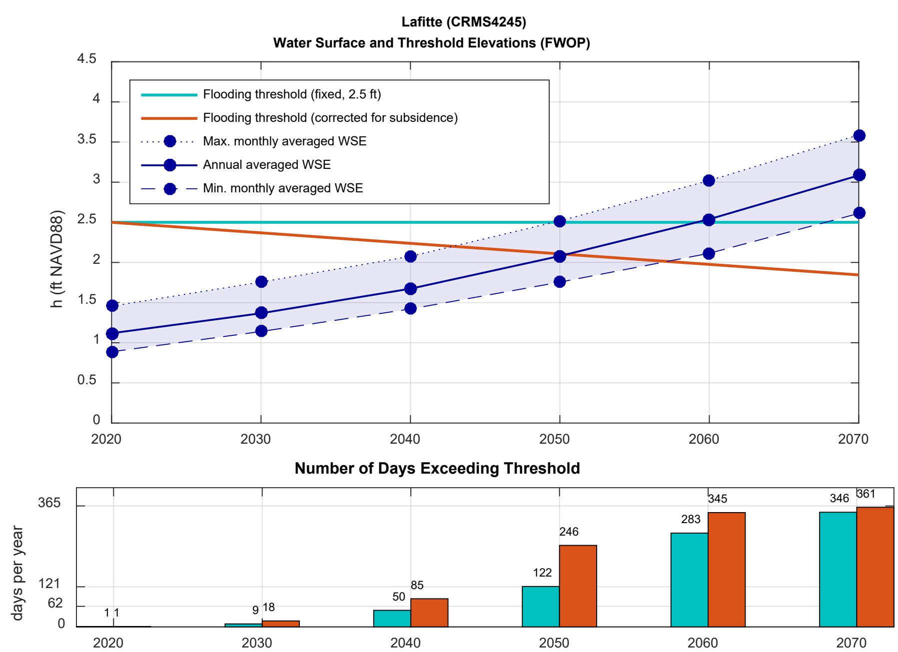


Figure 6: Analysis of the WSE in Lafitte over time, FWOP simulation, 2011 hydrograph. (Top graph) Annual average WSE (blue solid line) and its range of variation (min/max monthly average, blue dotted lines), fixed WSE thresholds (green line) and WSE threshold corrected with subsidence (orange line). (Bottom graph) Annual number of days exceeding the fixed WSE threshold elevation (green) and the corrected threshold elevation (orange). WSE is referenced to NAVD88 (GEOID12A).

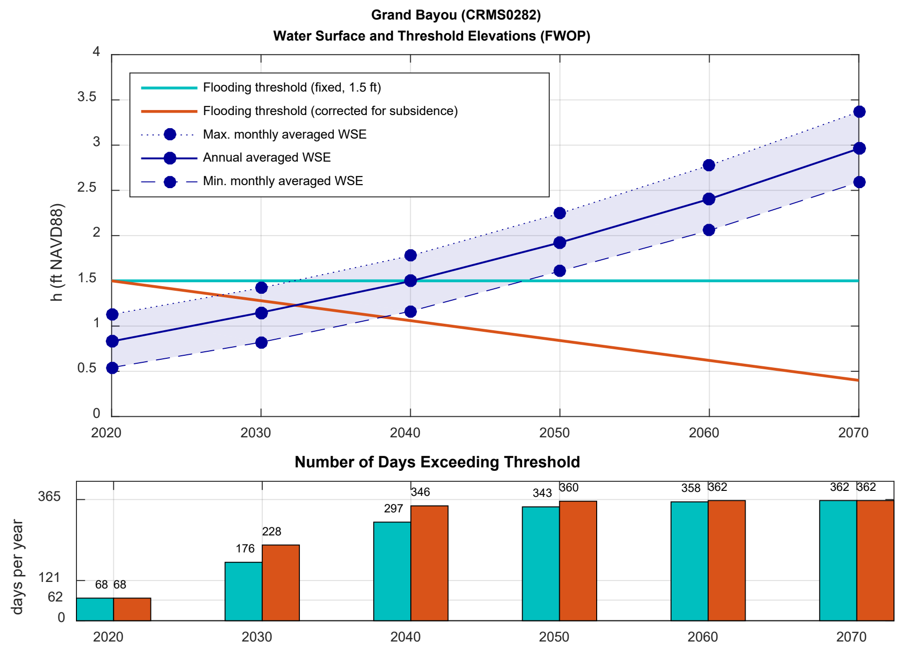


Figure 7: Analysis of the WSE in Grand Bayou over time, FWOP simulation, 2011 hydrograph. (Top graph) Annual average WSE (blue solid line) and its range of variation (min/max monthly average, blue dotted lines), fixed WSE thresholds (green line) and WSE threshold corrected with subsidence (orange line). (Bottom graph) Annual number of days exceeding the fixed WSE threshold elevation (green) and the corrected threshold elevation (orange). WSE is referenced to NAVD88 (GEOID12A).

An overview of the effect of different Mississippi River hydrographs on the threshold exceedance rates is shown in Figure 8 to Figure 10 for each of the three communities. These figures show the influence of the river discharge on FWOP exceedance rates for a fixed threshold (green bars) and for a threshold corrected with subsidence rate (orange bars). Overall the figures show that for FWOP conditions, the effect of the river discharge on WSE threshold exceedances annually is small, though not entirely negligible. The most noticeable difference is the lower exceedance rates for 2006 compared to the other hydrograph years. This is because 2006 is the only low-discharge year included in this analysis (Figure 2B).

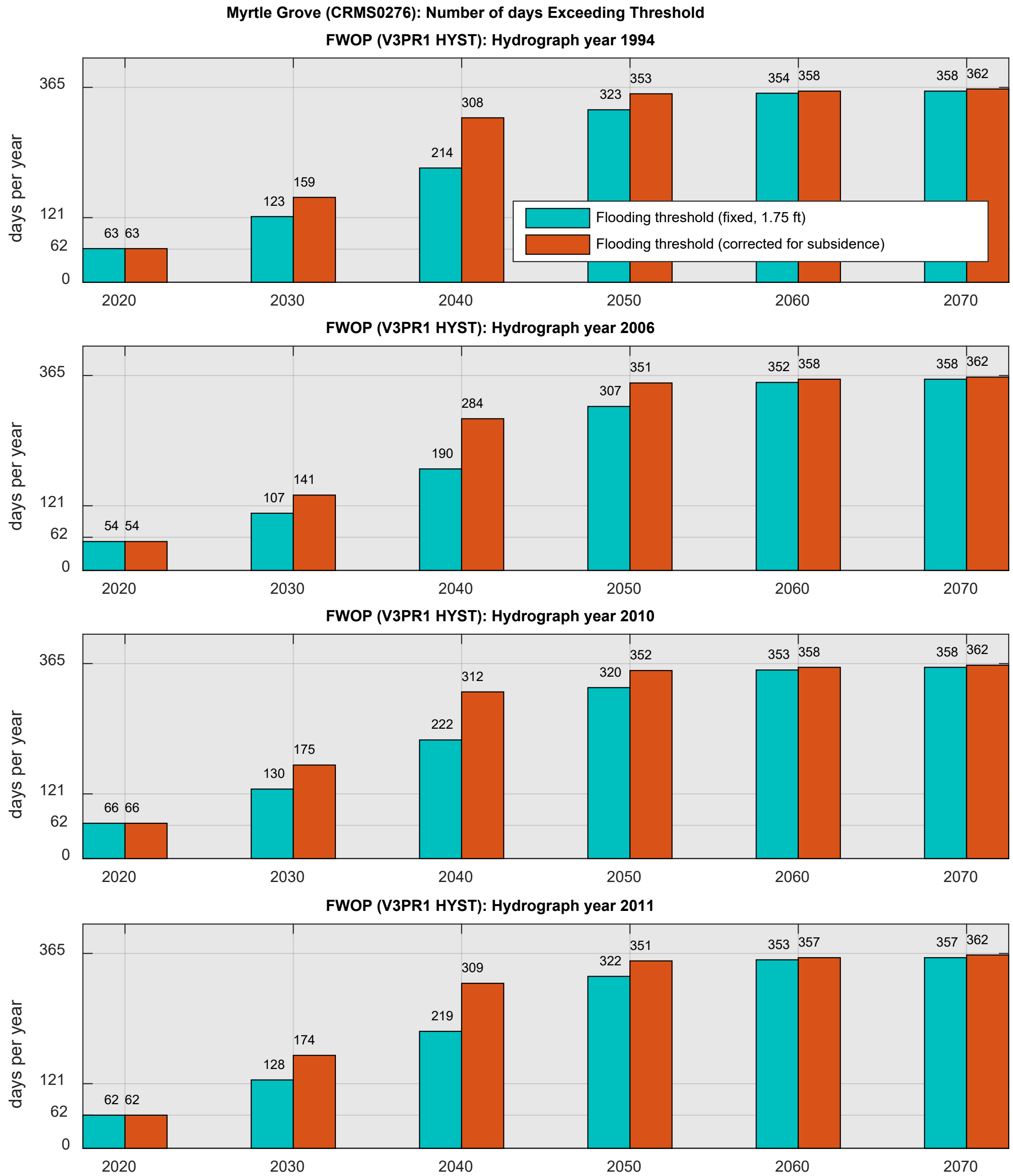


Figure 8: Analysis of the threshold exceedance rates in Myrtle Grove over time, FWOP simulation, all hydrographs. Annual number of days exceeding the fixed WSE threshold elevation (green) and the threshold elevation corrected for subsidence (orange).

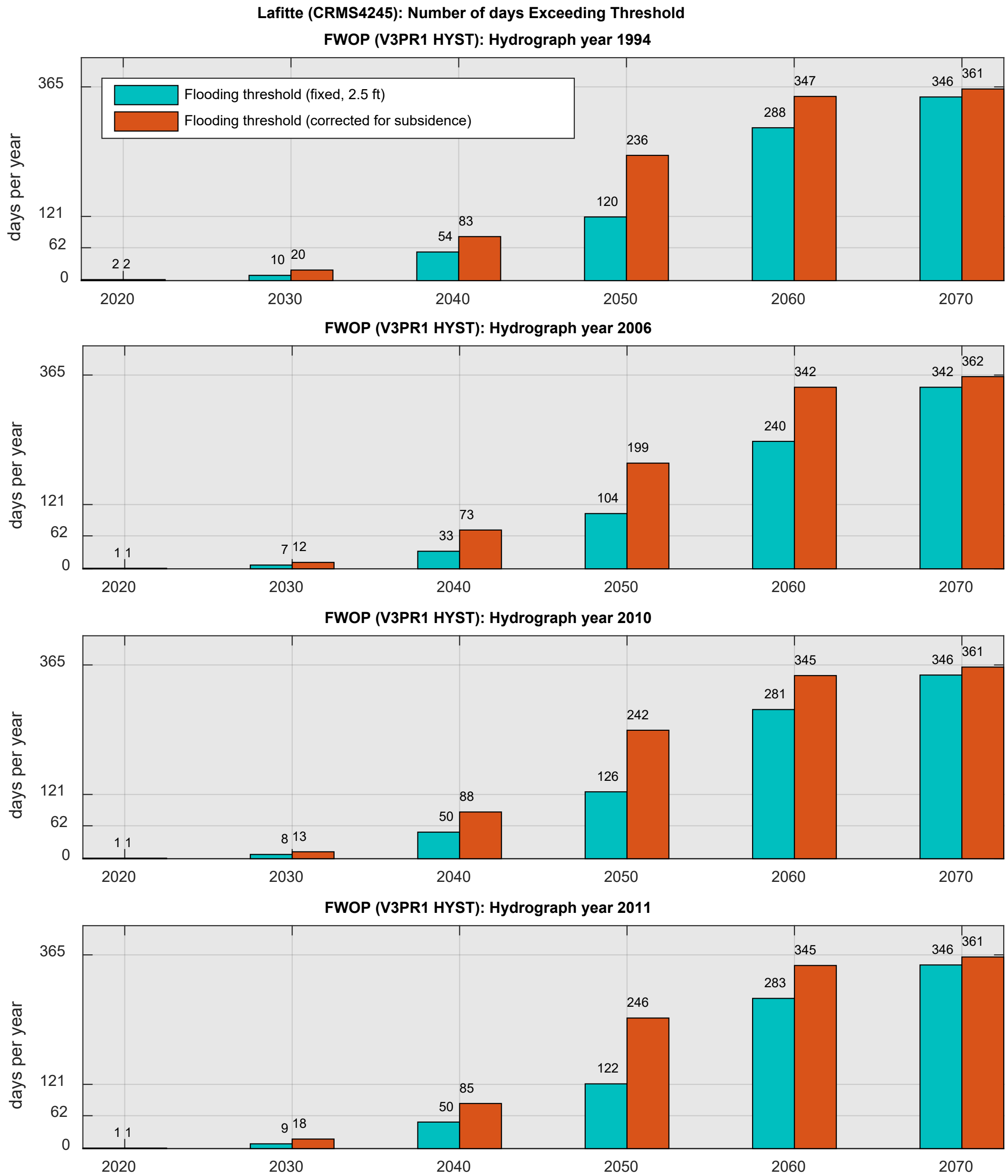


Figure 9: Analysis of the threshold exceedance rates in Lafitte over time, FWOP simulation, all hydrographs. Annual number of days exceeding the fixed WSE threshold elevation (green) and the threshold elevation corrected for subsidence (orange).

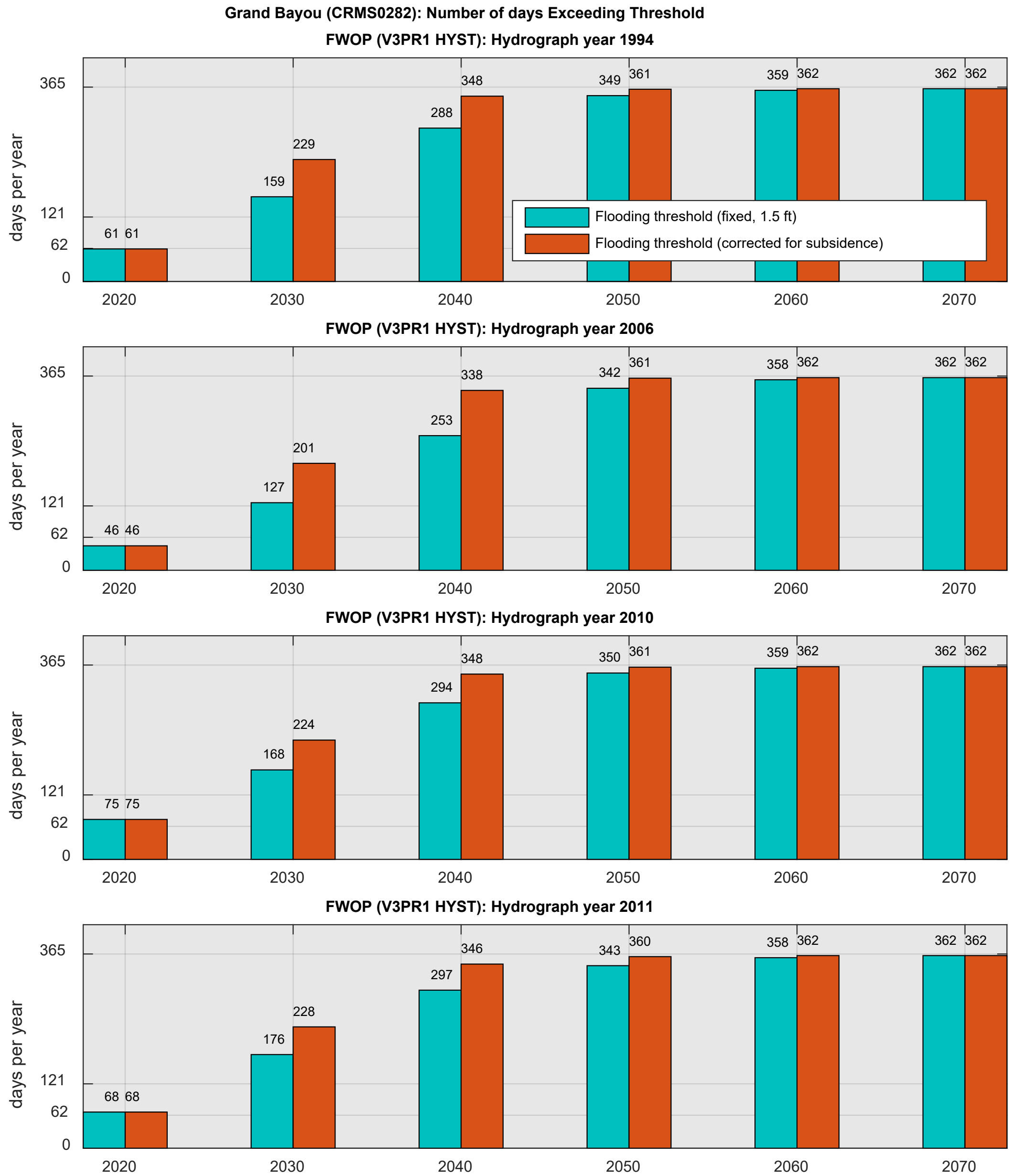


Figure 10: Analysis of the threshold exceedance rates in Grand Bayou over time, FWOP simulation, all hydrographs. Annual number of days exceeding the fixed WSE threshold elevation (green) and the threshold elevation corrected for subsidence (orange).

More detailed model results for each of the three communities are summarized in Figure 11 to Figure 16. Each figure includes instantaneous water level, mean monthly water level, the distribution of maximum daily water levels, and the number of days exceeding the fixed exceedance threshold (i.e., not adjusted for subsidence). The instantaneous water levels are direct model outputs and have a frequency of 1-hour. Monthly mean water levels are an average of the instantaneous water levels for each calendar month. The distribution of maximum daily water levels shows the variability in WSEs in a given month. The number of days exceeding the threshold are calculated by tallying every calendar day which experiences a WSE that exceeds the defined fixed threshold, regardless of the duration. Note that the number of days exceeding the threshold are defined by the fixed WSE threshold rather than a corrected threshold that accounts for subsidence.

Some notable considerations and observations from analysis of Figure 11 through Figure 16[5]:

- The decades highlighted for each community were selected based on the trends in the number of days exceeding the WSE thresholds as described in the analysis of Figure 5 through Figure 7. Specific decades were selected to highlight tipping points for exceedance thresholds. The 2020s through 2040s are highlighted for Myrtle Grove and Grand Bayou. Conversely, the 2050s and 2060s are highlighted for Lafitte, with the 2020s included as a baseline for comparison.
- Peak instantaneous WSEs are highest during short duration storm events in the spring. Several events occur between February and May resulting in elevations higher than 2.5 feet NAVD88. During many, though not all years, the MBSD diversion could be in operation during events like these. To better understand the potential impact of the MBSD on WSEs during events like these (i.e., during episodic events versus longer, averaged time periods), the spatial comparison of WSEs for FWOP and FWP is summarized in the subsequent FWP section.
- The increases in monthly averaged water levels are similar across all months and communities. The increases are generally reflective of the addition of ESLR.
- Myrtle Grove will experience threshold exceedances during 15-20% of the days of the year by the 2020s (Figure 11). This gradually increases from to 30% in the 2030s to 60% in the 2040s (Figure 12). The community experiences near-continuous WSE threshold exceedance throughout the months May to October during the latter decade.
- Lafitte will experience infrequent high-WSEs that exceed the threshold during the first decade (2020s) due to the relative higher elevation threshold (Figure 13). The community will not be significantly affected by an increase in WSEs until the 2040s. The threshold is predicted to be exceeded during several weeks in the 2040s, more than 50% of the time during several months in the 2050s and more than 75% of the time during the 2060s (Figure 14).

The community of Grand Bayou is predicted to be highly vulnerable to an increase in coastal WSEs. Model results indicate that elevation thresholds will be exceeded during approximately 20% of the days in the 2020s and nearly half of the days in the 2030s, as indicated in Figure 15. One decade later (2040s),

[5] Note that the model has a 3-day spin-up period January 1-3 during which outputs are not saved. Because of this, the maximum possible number of days for threshold exceedance based on model outputs are 28 days for January

threshold exceedance in Grand Bayou is predicted to occur throughout the year independent of season as shown in Figure 16.

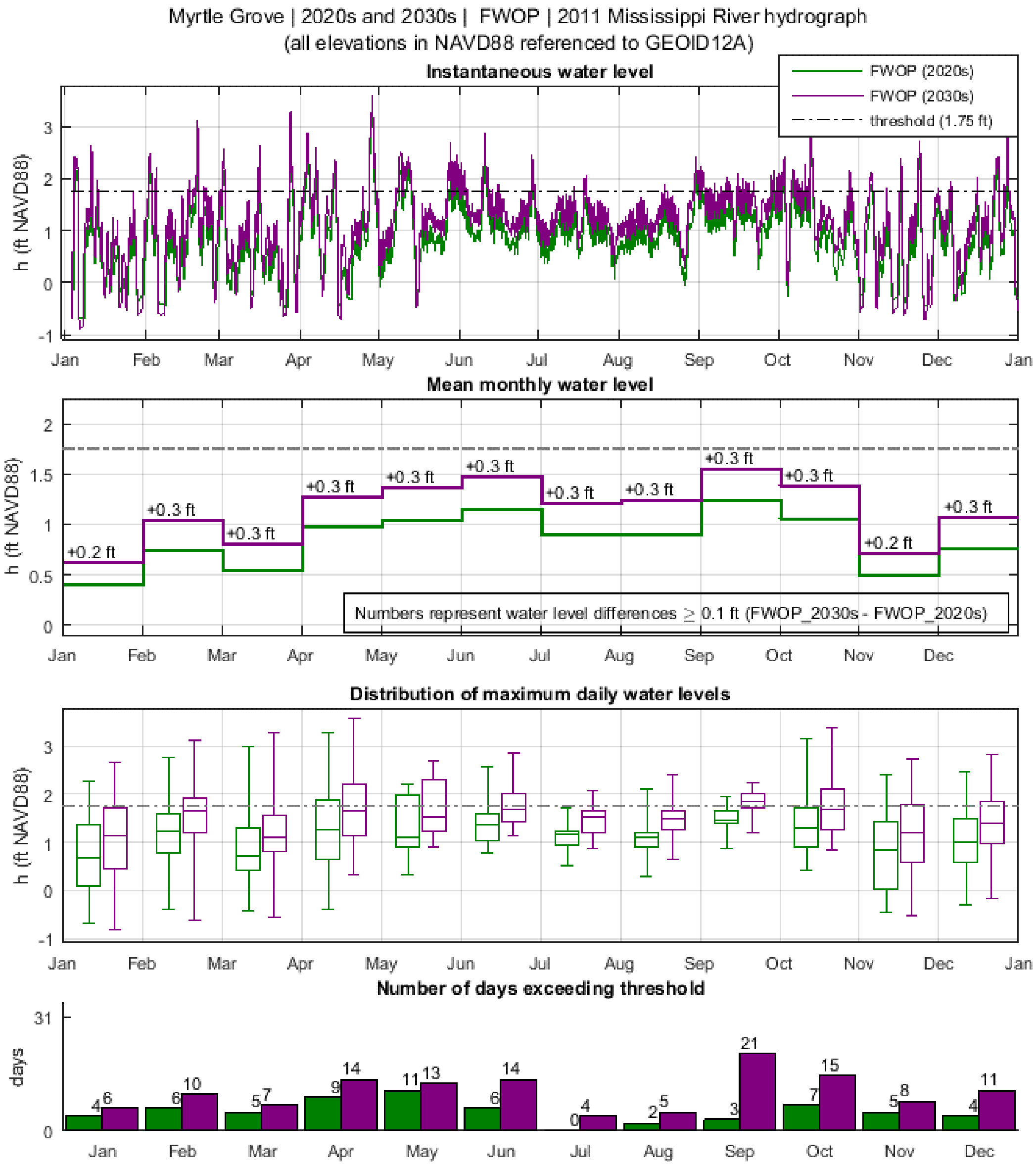


Figure 11: WSE analysis for Myrtle Grove, FWOP for the first decade (2020s, in green) and the second decade (2030s, in purple), using the hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

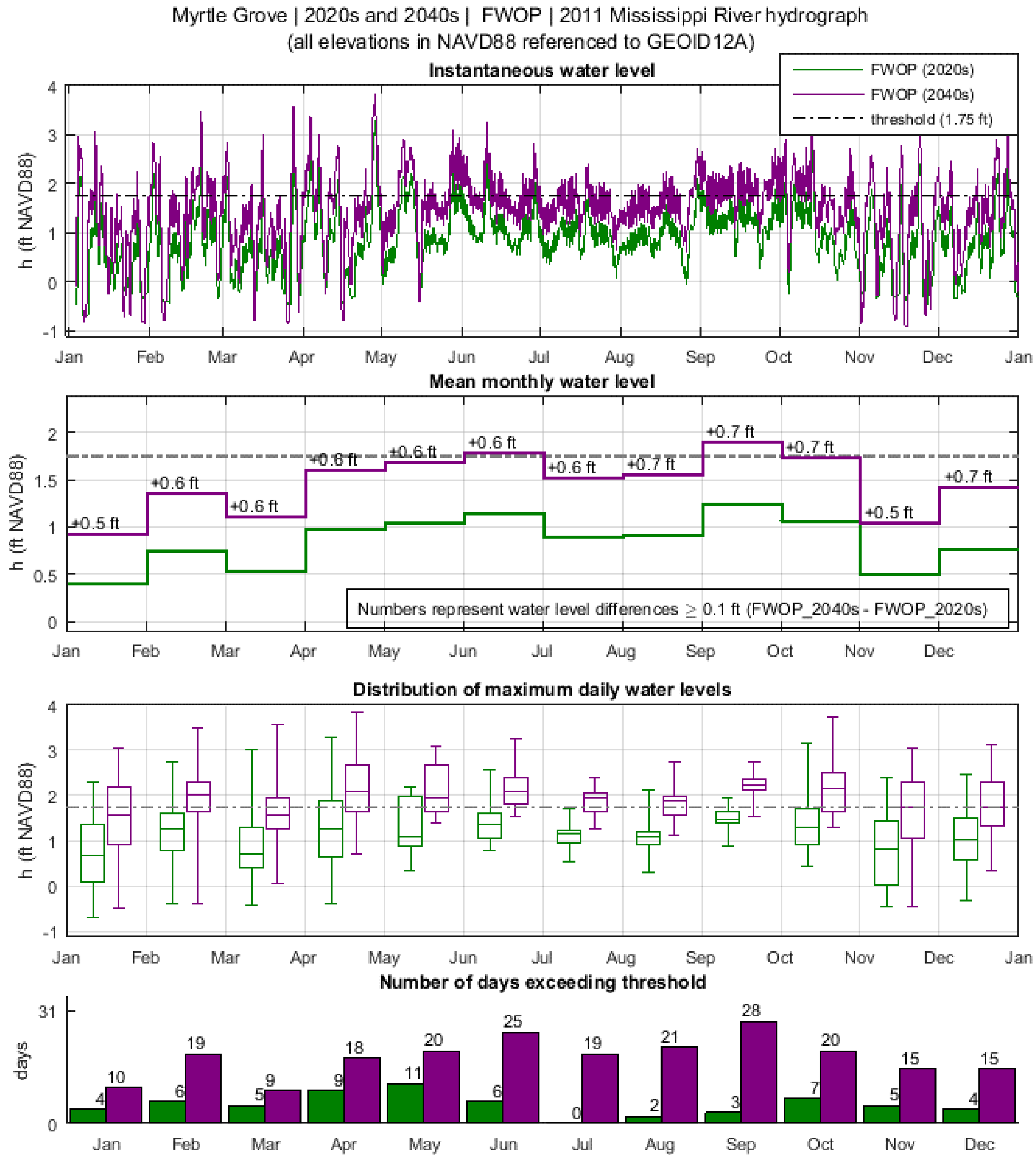


Figure 12: WSE analysis for Myrtle Grove, FWOP for the first decade (2020s, in green) and the third decade (2040s, in purple) , using the hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

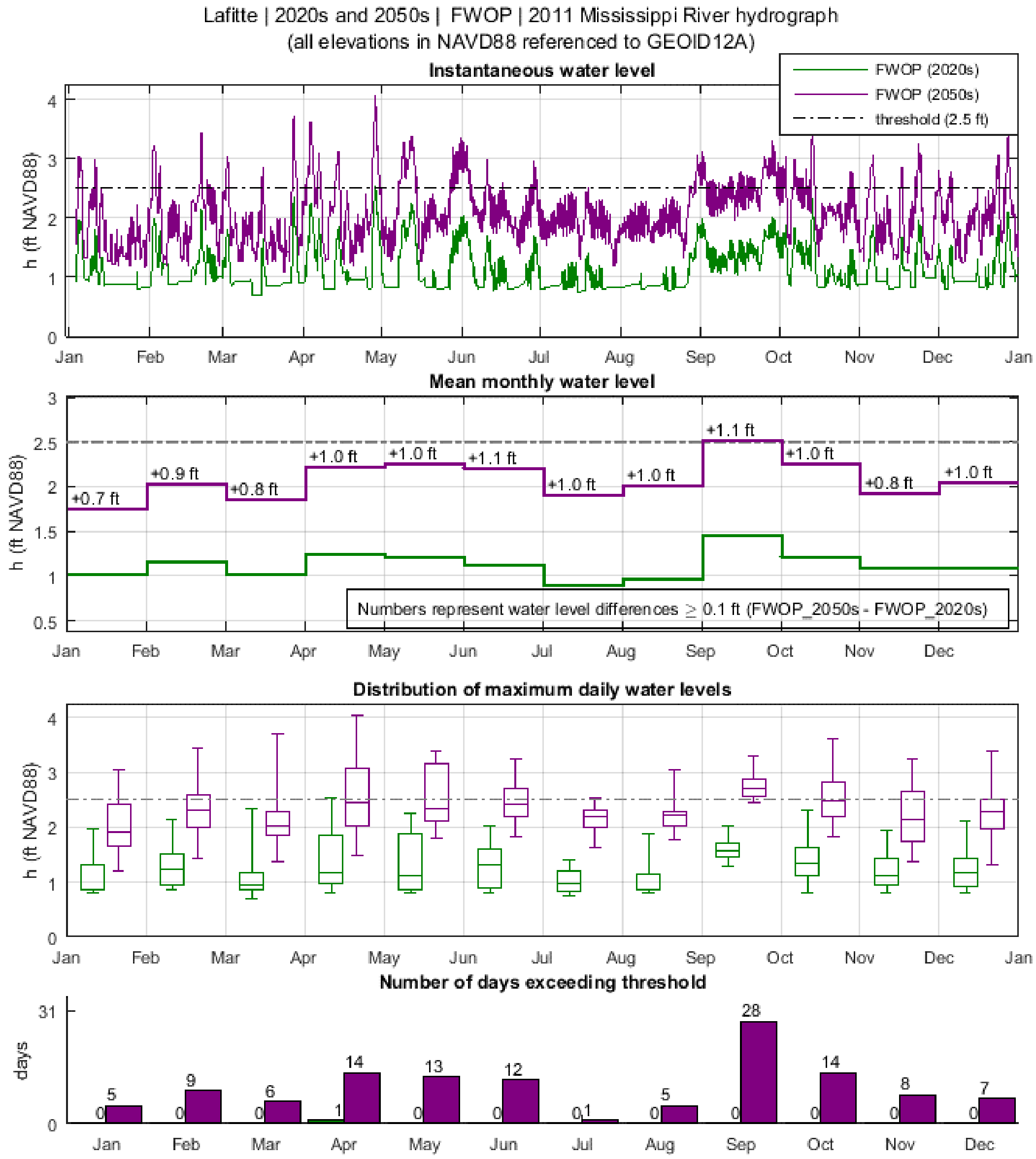


Figure 13: WSE analysis for Lafitte, FWOP for the first decade (2020s, in green) and the fourth decade (2050s, in purple), using the hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

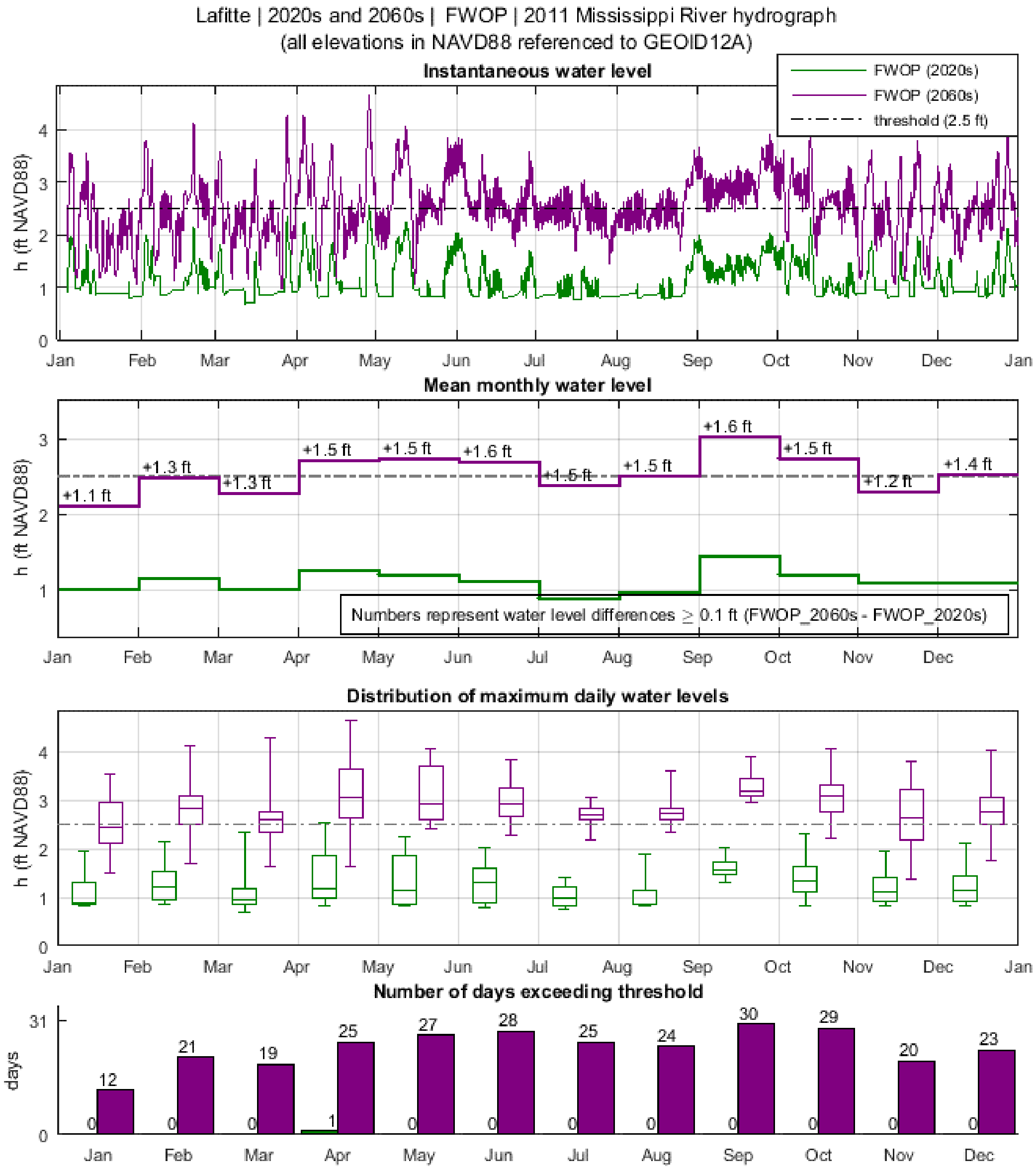


Figure 14: WSE analysis for Lafitte, FWOP for the first decade (2020s, in green) and the fifth decade (2060s, in purple), using the hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

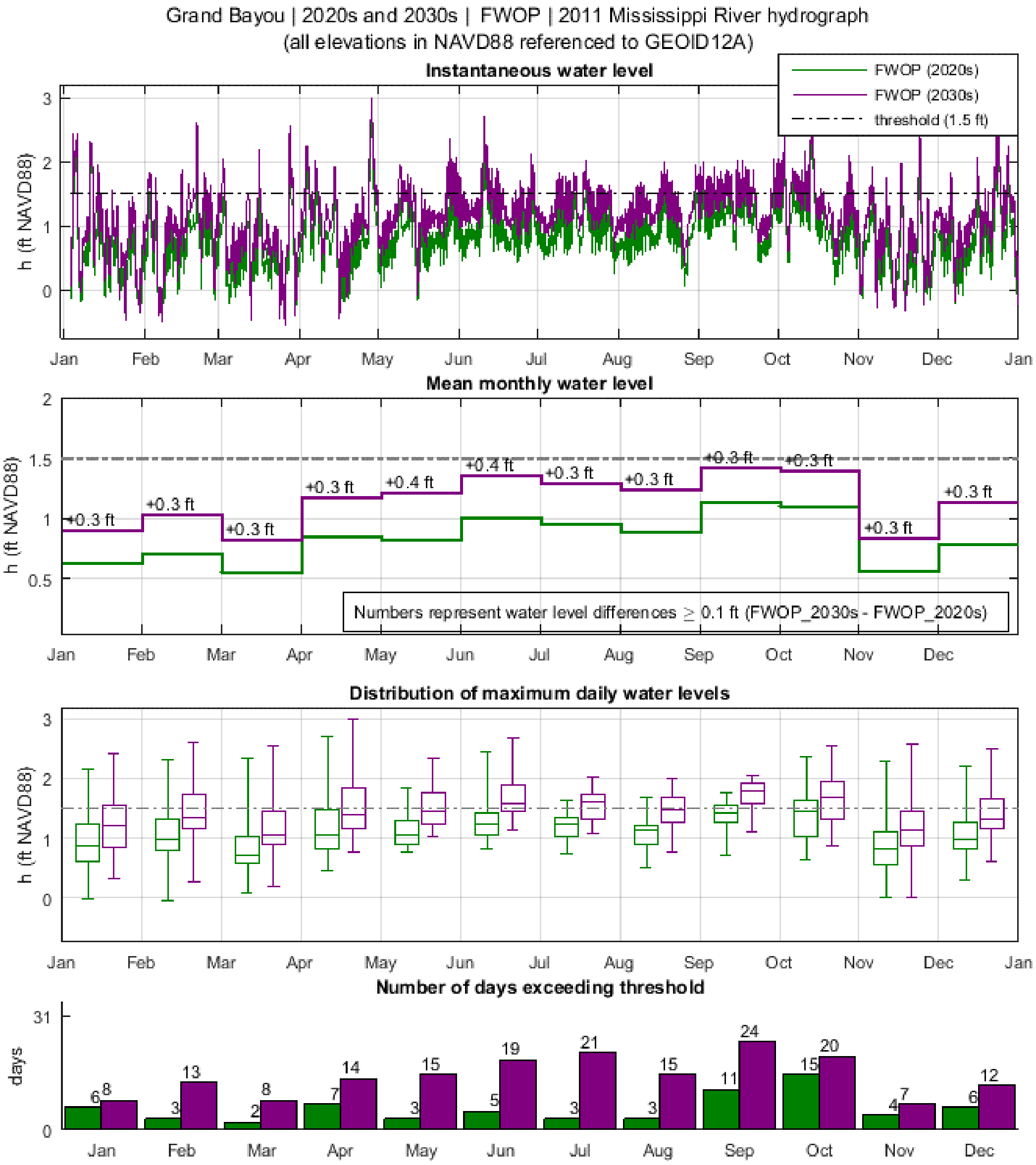


Figure 15: WSE analysis for Grand Bayou, FWOP for the first decade (2020s, in green) and the second decade (2030s, in purple), using the hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

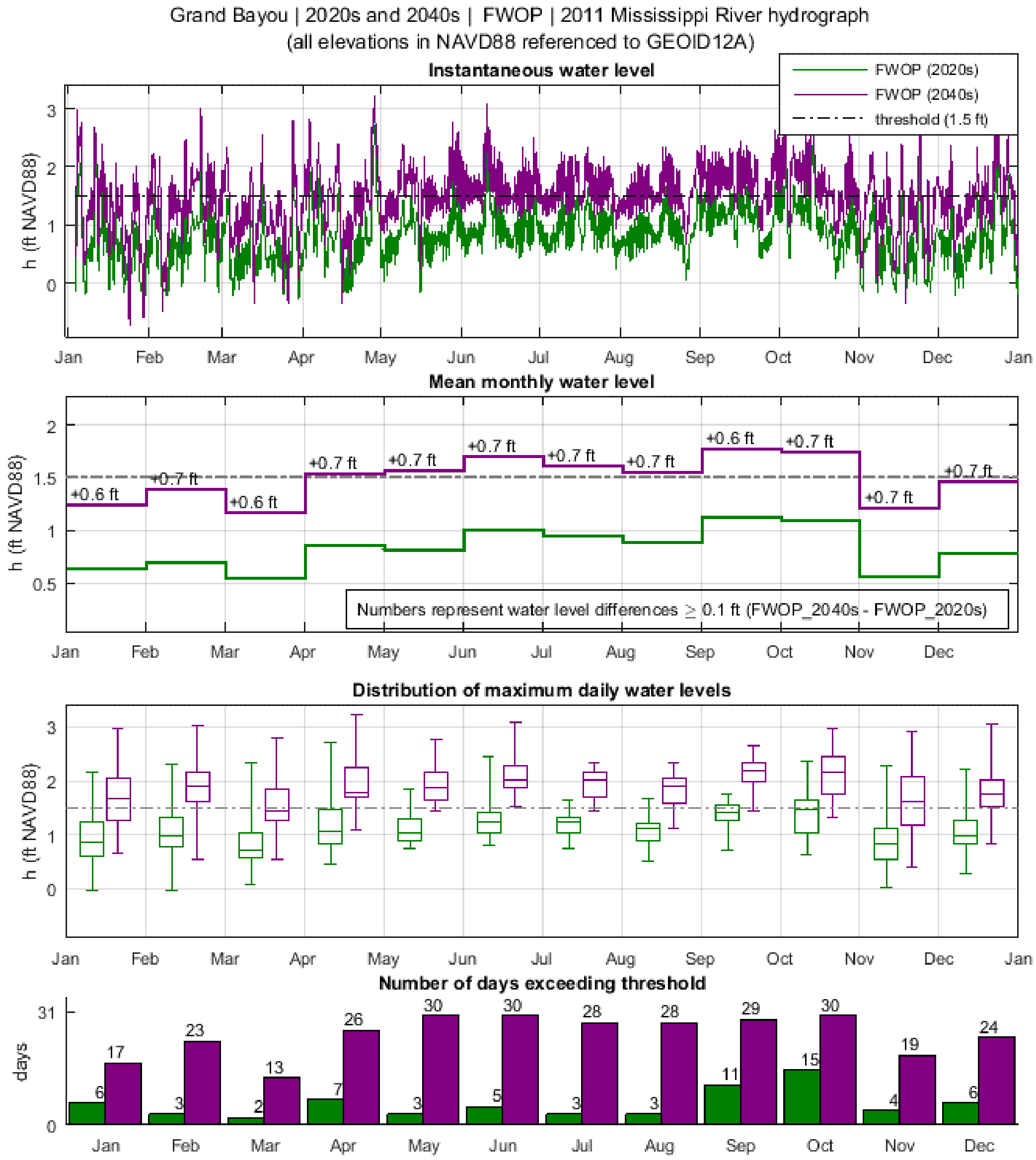


Figure 16: WSE analysis for Grand Bayou, FWOP for the first decade (2020s, in green) and the third decade (2040s, in purple), using the hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Future With Project

A comparison of the WSE threshold exceedance differences between the Applicant Preferred Alternative (i.e., V3PR4 - 75k cfs capacity) and the FWOP is presented in this section. The results for the 50k (V3PR2) and 150k cfs capacity (V3PR6) are presented and discussed briefly in Appendix C. In this section a short-term impact (i.e., cycle 0, 2020s), medium term impact (i.e., cycle 2, 2040s), and long-term impact (i.e., cycle 4, 2060s) are presented, as well as a spatial analysis to evaluate the impact of the diversion on WSE.

Vertical Elevation Analysis

Table 5 presents a summary of the monthly average water level variation induced by the diversion for all three FWP alternatives when compared to FWOP. Of the three communities, the WSEs near Myrtle Grove are most impacted by the diversion operation because of its proximity to the diversion site. As expected, with an increase in diversion capacity, the average WSEs increase. Additionally, due to ESLR effects, the magnitude of the average WSE impact associated with the diversion decreases over time for all three communities and all three diversion capacities.

Table 5: Summary of monthly average WSE increase induced by the diversion when fully operational. Values based on the 2011 Mississippi River hydrograph. The Applicant Preferred Alternative (75k cfs) is highlighted in bold.

Maximum monthly averaged WSE increases due to diversion operation (ft, relative to FWOP)										
Cycle	**Decade**	Myrtle Grove			Lafitte			Grand Bayou		
		50k	**75k**	150 k	50k	**75k**	150 k	50k	**75k**	150 k
cy 0	2020s	1	**1.3**	1.9	0.2	**0.3**	0.6	0.4	**0.5**	0.8
cy 1	2030s	0.8	**1.1**	1.8*	0.2	**0.3**	0.6	0.2	**0.3**	0.6
cy 2	2040s	0.7	**0.9***	1.7*	0.2	**0.3**	0.6	0.2	**0.3**	0.4
cy 3	2050s	0.4*	**0.8***	1.4*	0.2	**0.2**	0.5	0.1	**0.2**	0.2
cy 4	2060s	0.3*	**0.6***	1.3*	0.1	**0.2**	0.4	<0.1	**0.1**	0.1
cy 5	2070	0.2*	**0.4***	1.6*	0.1	**0.1**	0.3	<0.1	**<0.1**	0.1

**The estimated values for Myrtle Grove marked with an asterisk (*) are significantly influenced by the specific land building patterns. In some cases, the land building causes the bed level to exceed the WSE during parts of the year with lower absolute WSEs, thus estimations are made based on monthly averages unaffected by this phenomenon.*

Short-term

During the first decade (2020s), the 75k cfs diversion was predicted to affect the WSEs adjacent to the community of Myrtle Grove with an increase in monthly average water level up to 1.3 ft relative to the FWOP values. The WSE threshold near Myrtle Grove is exceeded in the FWOP conditions for a significant portion of the year (Figure 17). During the months of March to July, the FWP model predicts over double the number of threshold exceedances than FWOP.

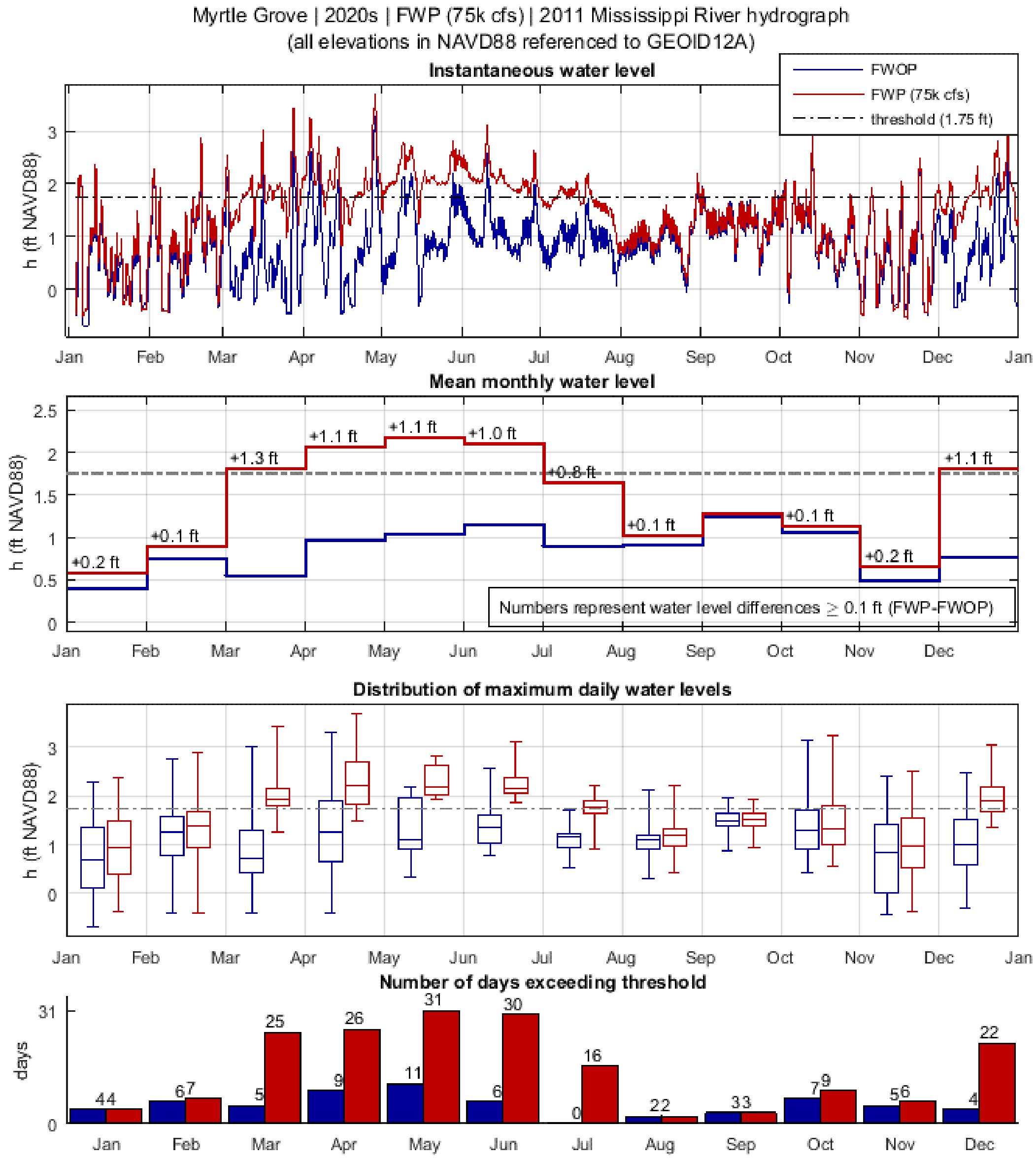


Figure 17: Analysis of diversion impact on WSEs in Myrtle Grove during the 2020s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

The predicted WSE elevation increase near Lafitte is not significant for the 75k diversion operation in the short-term because the WSE threshold is higher than the other two communities. Comparison of the WSE threshold line and both the instantaneous and monthly average water levels in Figure 18 illustrates the limited impact associated with the diversion. The monthly averaged WSEs were predicted to increase up to 0.3 ft relative to the FWOP. For the first decade, the number of days exceeding the threshold is less than five for the FWP and FWOP conditions.

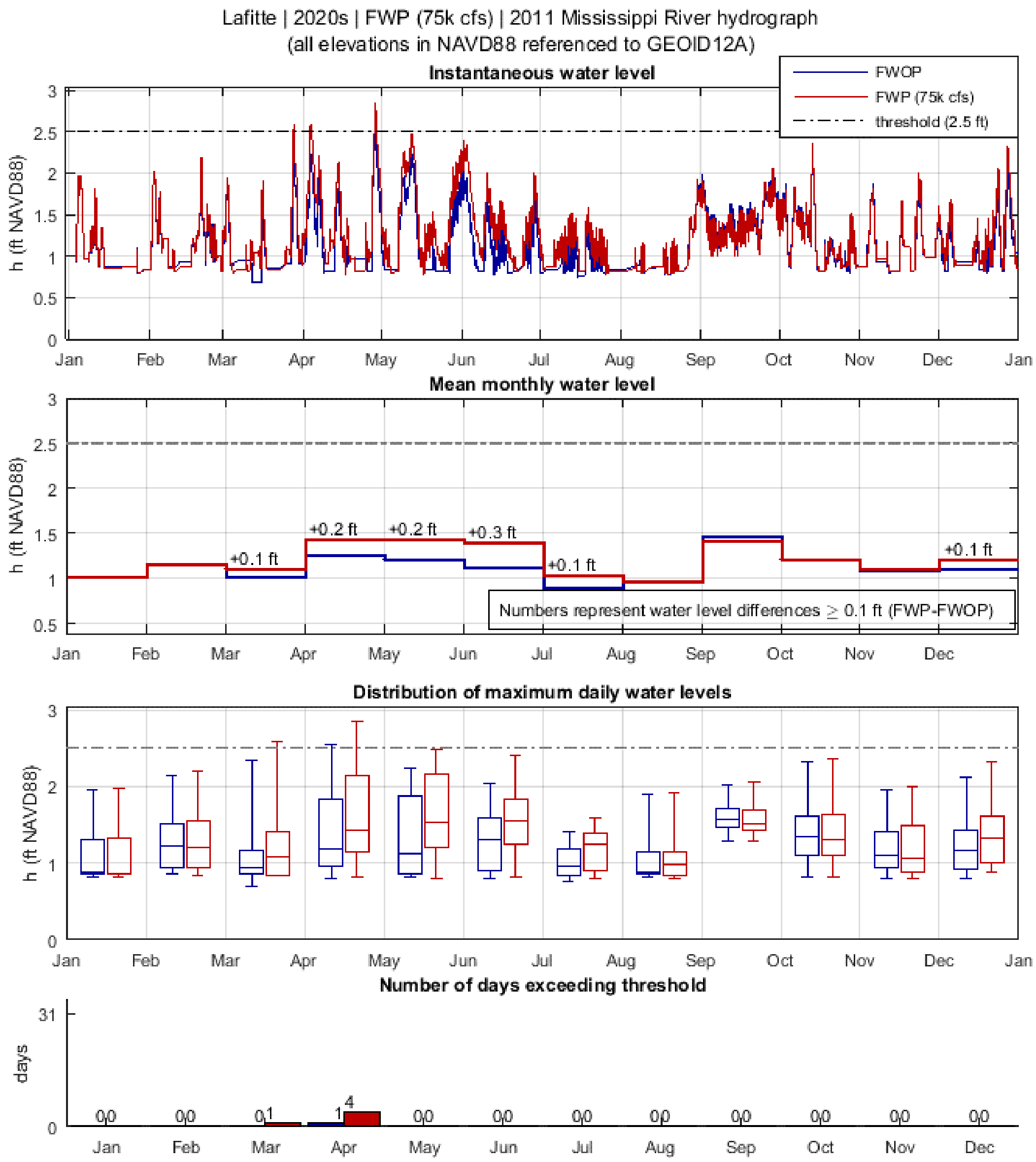


Figure 18: Analysis of diversion impact on WSEs in Lafitte during the 2020s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

The 75k cfs scenario was predicted to affect the monthly averaged WSE near Grand Bayou up to 0.5 ft. Because of the relatively low elevation of the community, the WSE increases of tenths of a foot result in more frequent exceedance of the WSE threshold. In some months the number of days of threshold exceedance increase by as much as 15 days as shown in Figure 19. Increases in the number of days exceeding the WSE threshold will also be sensitive to diversion operations in the near term, with most of the increased days occurring in April through July when the diversion discharge is highest for the 2011 Mississippi River hydrograph. A comparison of the sensitivity of Mississippi River discharges is described in more detail in a subsequent section.

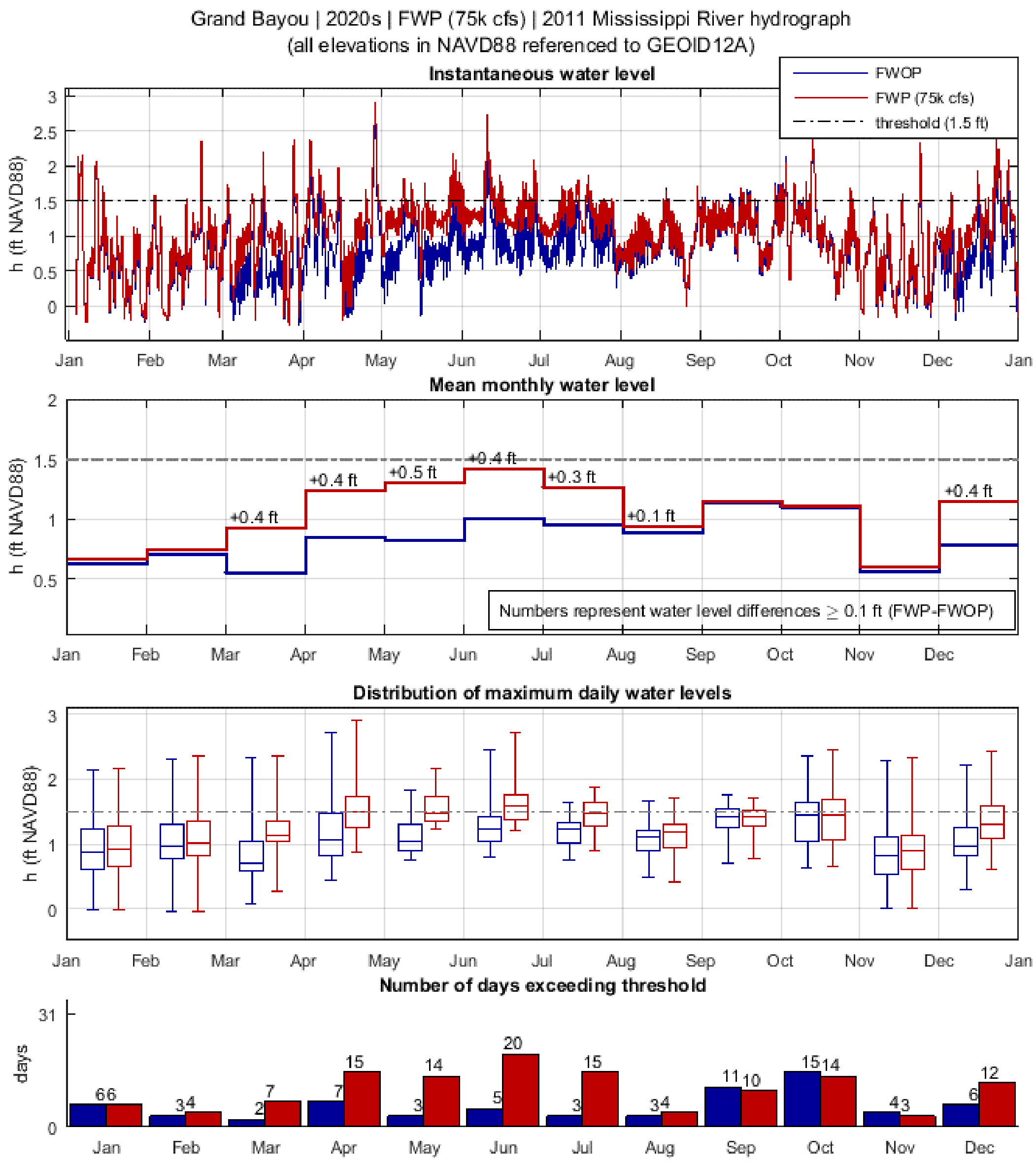


Figure 19: Analysis of diversion impact on WSEs in Grand Bayou during the 2020s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Medium-term

During the third decade of the study period (2040s), the model assumes an ESLR of 0.69 ft higher relative to the 2020s. Based on the outputs of the Basinwide V3 model, the WSEs nearest the diversion appear to be the only total water levels which are predominately affected by the diversion operation, rather than to RSLR, during this decade. Because of this, Myrtle Grove (due to its proximity to the diversion) is the only community that is expected to have a change in WSEs greater than 0.5 ft due to the diversion.

Figure 20 shows that the average monthly water level at Myrtle Grove increases up to 0.9 ft during diversion operation[6]. This is due to the proximity of Myrtle Grove to the diversion. It should be noted however that consistent with Figure 5, the total number of days of threshold exceedance over the course of the year is quite high regardless of the diversion operation, with over 200 days of threshold exceedance annually for FWOP assuming a fixed threshold elevation (and over 300 days assuming a threshold elevation adjusted for subsidence). Regardless of the notable increase in WSE associated with the diversion, the community will likely face considerable challenges due to RSLR impacts alone by the 2040s.

[6] Figure 20 shows a higher increase for March (1.0 ft) but this value is disregarded due to the elevated bed level (at ~1.5 ft) during this decade, truncating the lower FWP WSEs at the bed level. The truncation could lead to an overestimation of the mean monthly water level (and hence water level difference). Therefore, the maximum WSE difference is based on May instead of March.

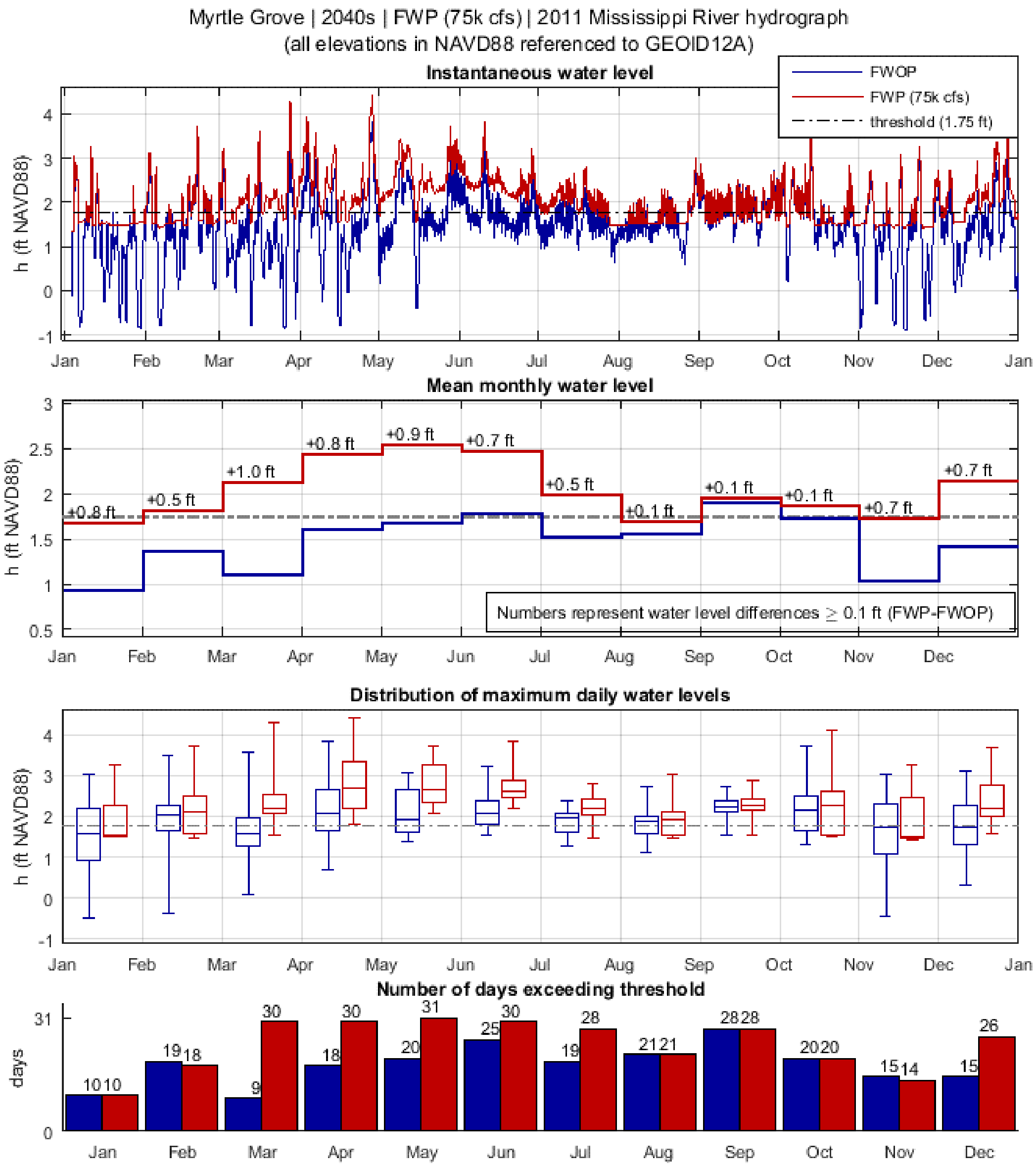


Figure 20: Analysis of diversion impact on WSEs in Myrtle Grove during the 2040s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

In contrast to the WSEs in Myrtle Grove affected by the diversion, the WSEs at Grand Bayou and Lafitte are primarily controlled by ESLR (i.e., a combination of current day tidal elevations, winds and ESLR are the primary drivers leading to the total WSE near the two communities). The monthly averaged water levels during diversion operations will increase slightly at Lafitte (+0.2 ft, see Figure 21) and Grand Bayou (+0.2ft, see Figure 22) relative to FWOP. Monthly average water levels in Lafitte are predicted to remain below the WSE threshold as shown in Figure 21, though many days will incur WSEs above the threshold for both FWOP and FWP conditions. Similar to Myrtle Grove, the Grand Bayou community will face considerable challenges due to RSLR impacts alone by the 2040s, as shown by the number of days exceeding threshold in Figure 22.

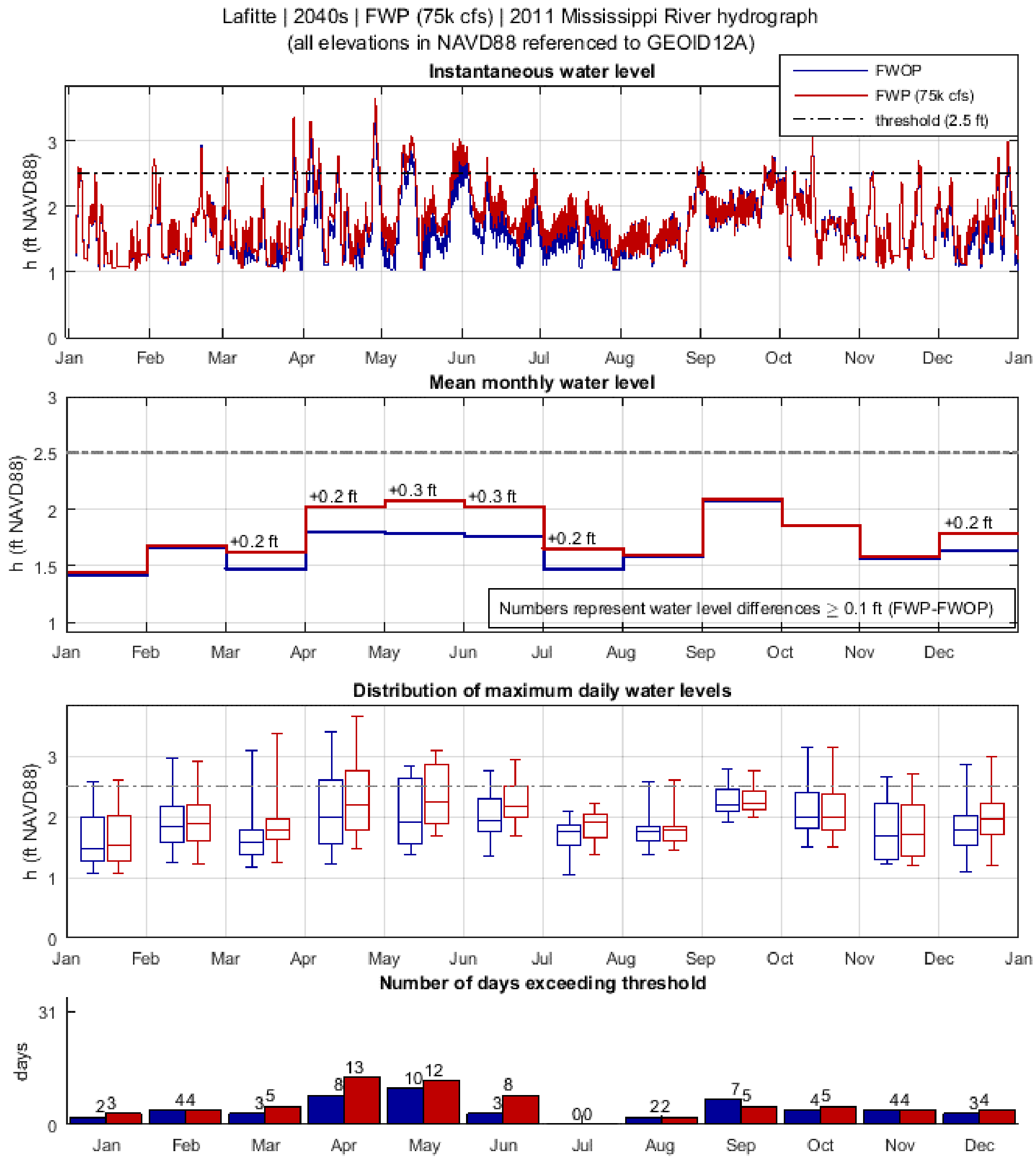


Figure 21: Analysis of diversion impact on WSEs in Lafitte during the 2040s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

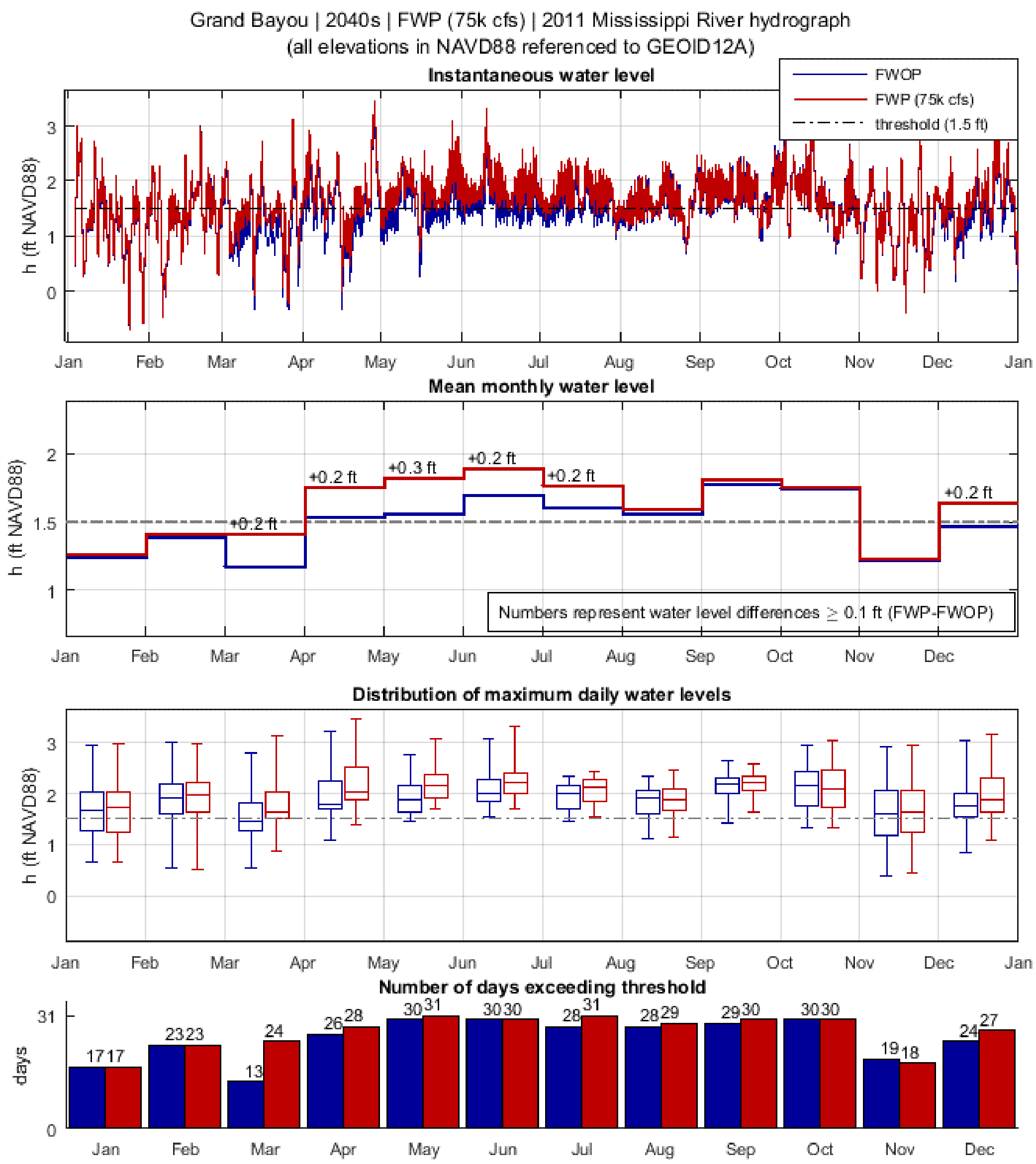


Figure 22: Analysis of diversion impact on WSEs in Grand Bayou during the 2040s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Long-term

During the fifth decade of the study period (2060s), the ESLR of 1.65 ft relative to 2020 was predicted to become the dominant factor causing WSE threshold exceedance in each of the three communities (see Figure 23 to Figure 25). The diversion operations have a less substantial impact on WSEs for the three communities when compared to previous decades (see Table 5). Additionally, elevation thresholds were exceeded for most days of the year during this decade due to ESLR and further compounded by subsidence. However, with the operation of the MBSD at 75k cfs, the water level was predicted to increase 0.6 ft relative to the FWOP at Myrtle Grove.

The predicted water levels near Myrtle Grove (Figure 23) were significantly influenced by the specific land building patterns (i.e., the location of features such as distributary channels, splays, and island building) predicted in each model simulation, especially in case of the 150k cfs diversion capacity (see Appendix C). While the approximate WSE and land building patterns predicted by the model are expected to be realistic, it should be noted that the absolute differences in WSEs will heavily depend on outfall management strategies which are not reflected in the modeling scenarios. Nonetheless, even with expected variability in land building patterns and the associated variability in WSEs, the trends documented herein are expected to remain the same with the WSEs for FWP being higher than FWOP and both FWP and FWOP resulting in WSEs that frequently exceed the defined thresholds.

Due to their distance from the MBSD outfall, the WSEs at both Lafitte (Figure 24) and Grand Bayou (Figure 25) are not significantly affected by the diversion during this time period. Both communities also experience frequent exceedance of WSE thresholds.

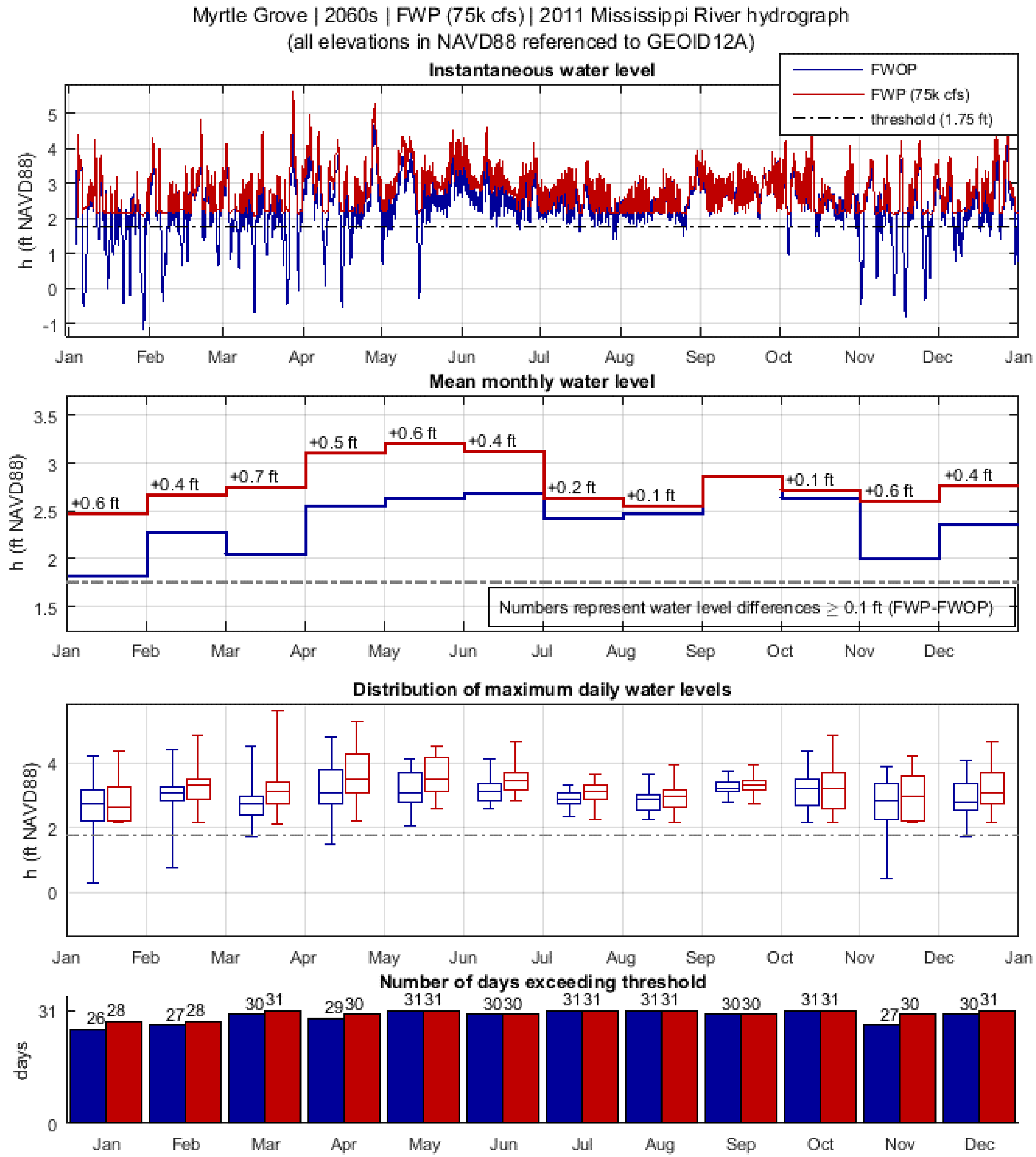


Figure 23. Analysis of diversion impact on WSEs in Myrtle Grove during the 2060s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

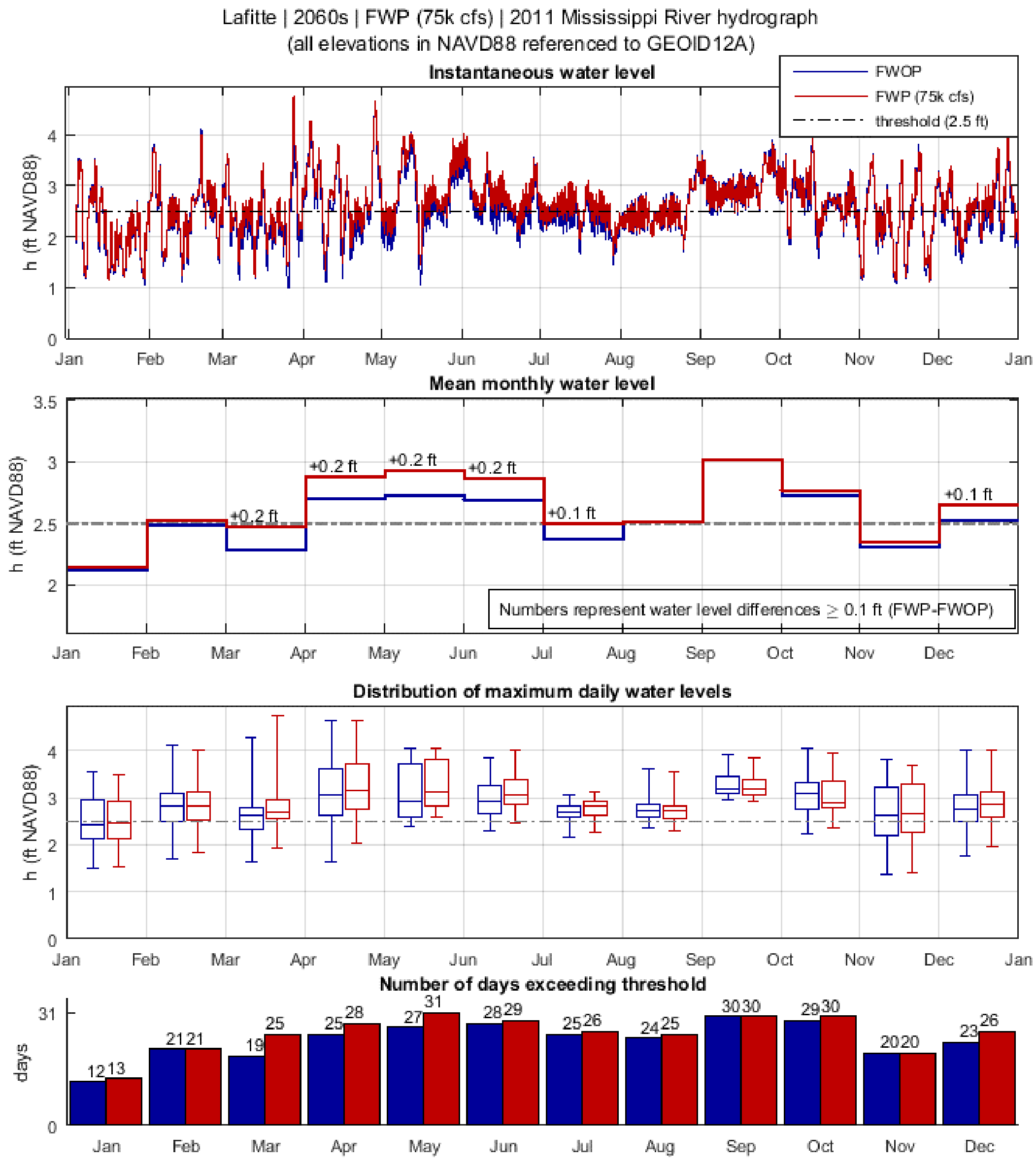


Figure 24. Analysis of diversion impact on WSEs in Lafitte during the 2060s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

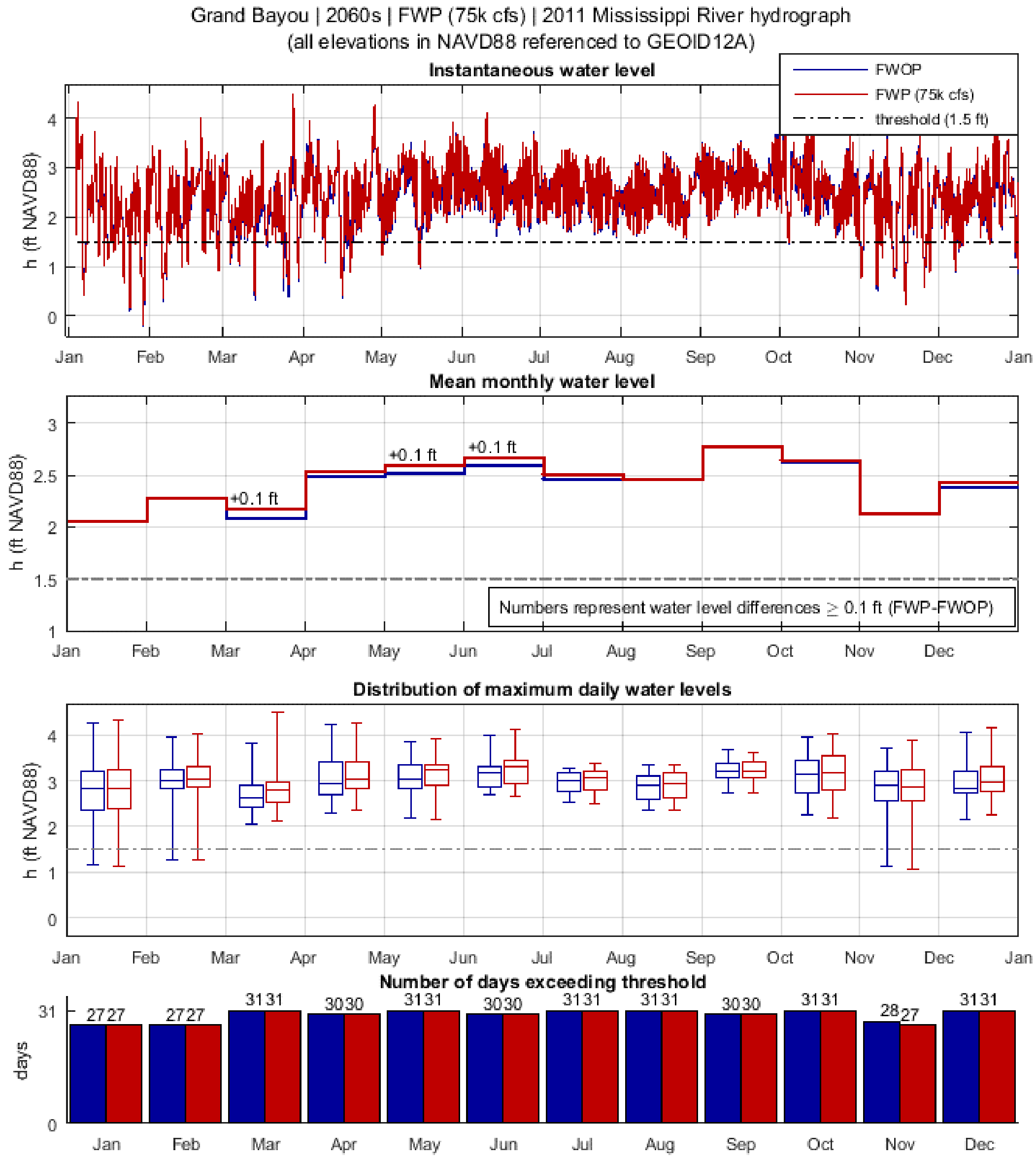


Figure 25. Analysis of diversion impact on WSEs in Grand Bayou during the 2060s, FWOP and FWP (75k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Spatial Analysis

In this section, the spatial extent of the diversion's influence on WSE is presented for the Applicant Preferred Alternative, using the 2011 hydrograph. The analysis includes (1) the WSE difference averaged over a week that the MBSD is operating at maximum discharge and (2) the WSE differences during select peak events (i.e., individual model time snaps). The WSE differences computed were based on the FWP Applicant Preferred Alternative (V3PR4, 75k cfs) relative to the FWOP (V3PR1).

MBSD Maximum Discharge – Spatial Trends in Elevation Differences

Figure 26 presents the average WSE difference between FWOP (V3PR1) and FWP (V3PR4, 75k cfs) for the first week of May in the 2020s (see Figure 2). This specific week has been selected because the MBSD was operating at maximum discharge (i.e., 75k cfs). The WSE difference most significantly affects the area near the outfall and extends south and east, up to the proximity of Grand Bayou community. The water level difference is 2-3 ft immediately adjacent to the diversion channel and gradually decreases with distance. The water level difference increases up to 1.5 feet near Myrtle Grove and less than 1 ft near Lafitte and Grand Bayou.

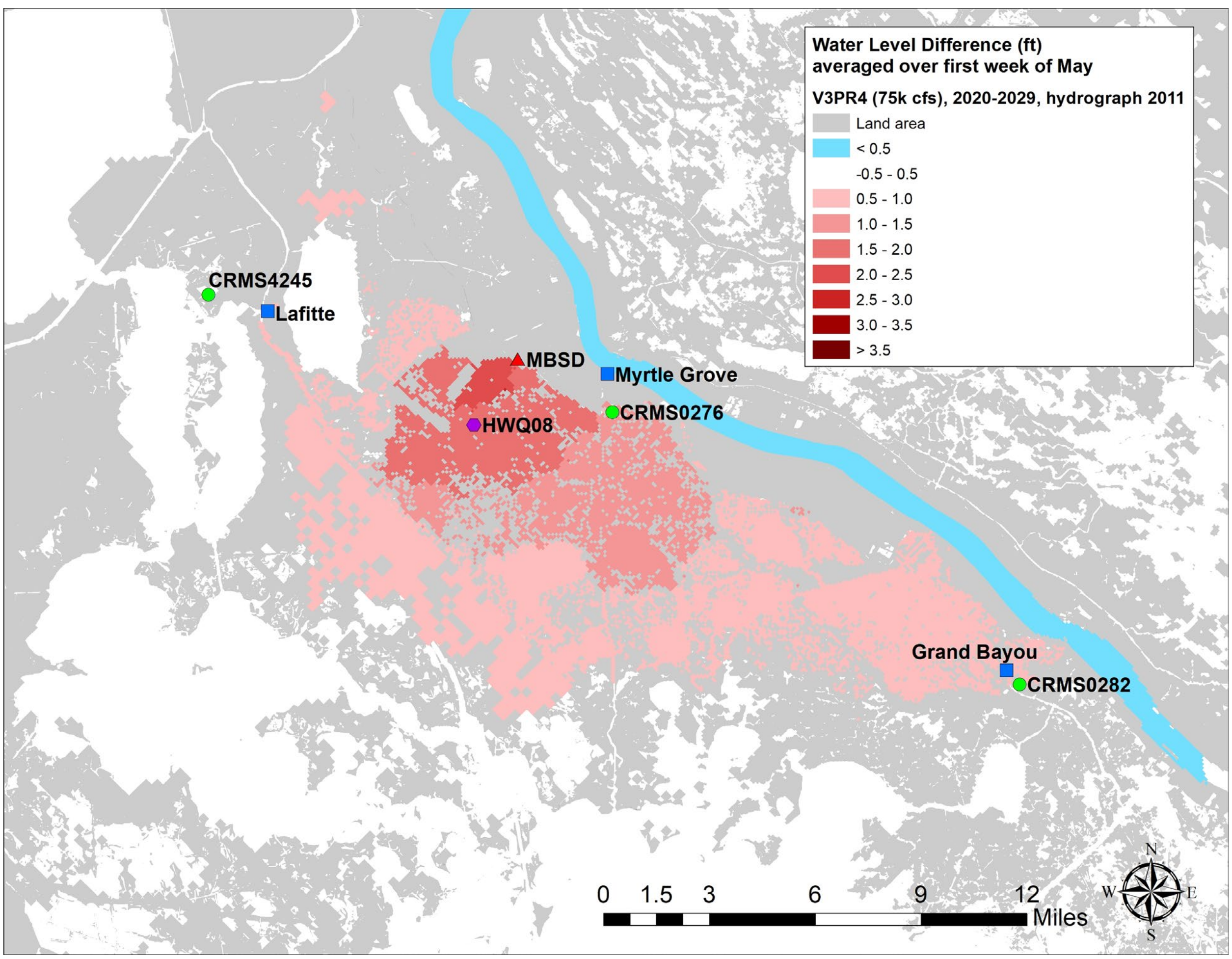


Figure 26: Average water level difference between FWOP (V3PR1) and FWP (V3PR4, 75k cfs) for the first week of May (in the 2020s), when the diversion is at maximum capacity (75k cfs).

Wind Driven Peak Water Levels – Spatial Trends in Elevation Differences

Some events have been selected to evaluate WSE trends and fluctuations due to non-tropical wind events within Barataria Basin. Station HWQ08 (see Figure 1 for its location) has been considered for this assessment because is the closest to the diversion outfall (<4 miles). For the HWQ08 station, the WSE timeseries for FWOP and for the FWP Applicant Preferred Alternative have been plotted (see Figure 27). By analyzing the trend of the FWOP WSE, some peak events have been selected: in March, April and May. All three selected events occur during a time that the diversion is in operation.

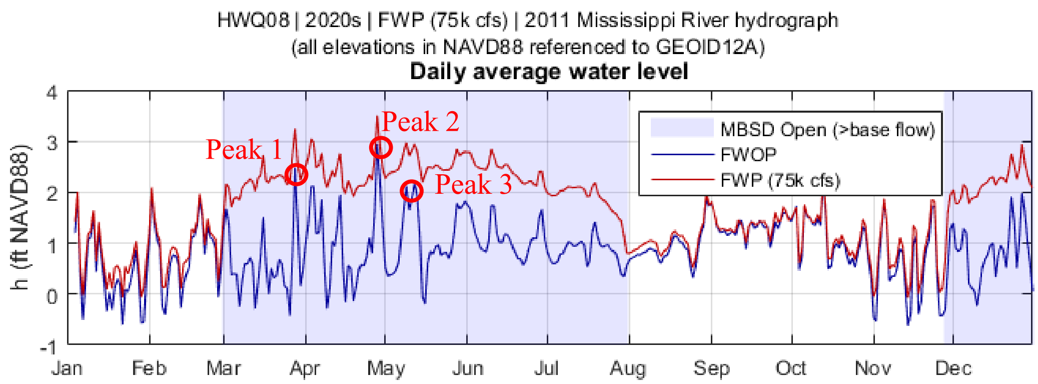


Figure 27: Daily averaged WSE timeseries for FWOP (V3PR1) and FWP (V3PR4) during the 2020s. Three peak events have been identified in red (top graph).

An analysis of the absolute WSE for FWOP and for the FWP Applicant Preferred Alternative was performed during these peaks, as well as a calculation of the WSE difference between FWOP and FWP. Figure 28 and Figure 29 show the instantaneous WSE for the FWOP and the Applicant Preferred Alternative for Peak 1 (March 28th). Note the highest WSEs in the Mississippi River, shown in red, as well as the increase in WSEs adjacent to the diversion outfall for the FWP condition.

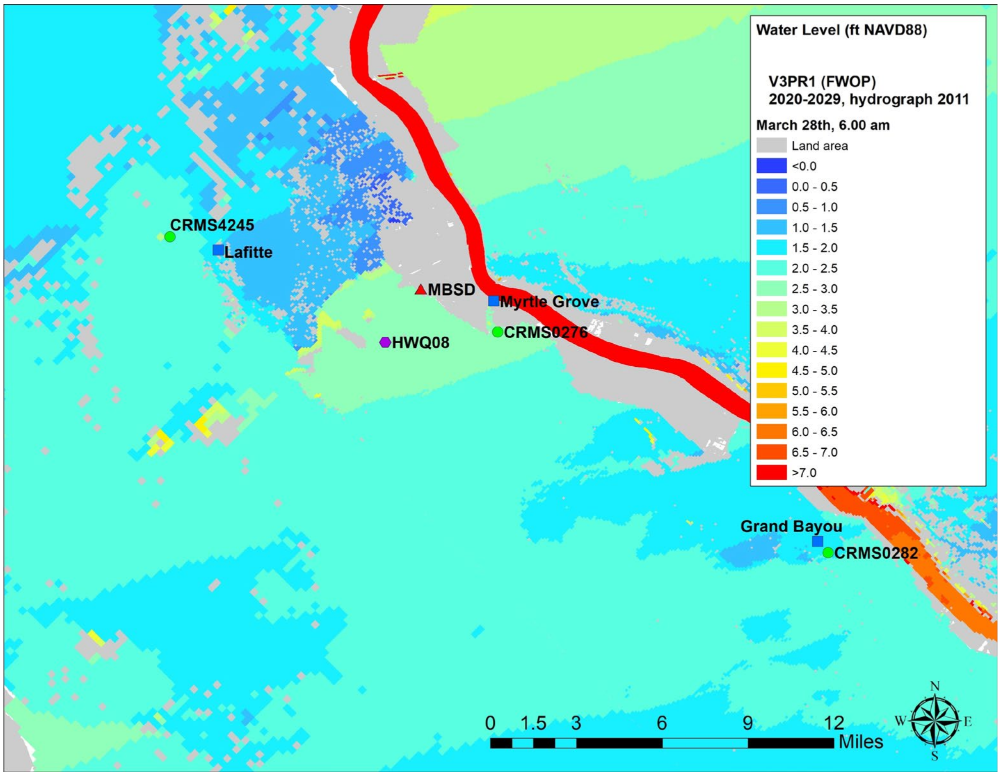


Figure 28: Instantaneous WSE (water level) for FWOP (V3PR1) during a wind driven peak event (Peak 1) during the 2020s.

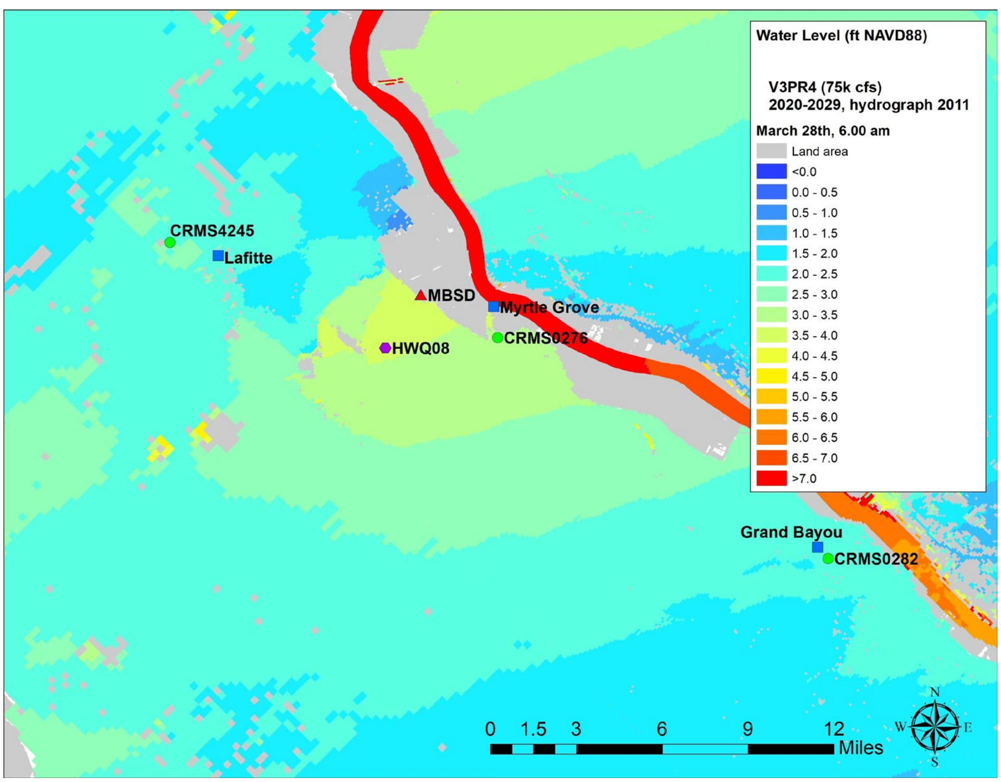


Figure 29: Instantaneous WSE for FWOP (V3PR1) during a wind driven peak event (Peak 1), during the 2020s.

The water level difference between the FWP 75k cfs and FWOP on March 28, 2011 at 6 am (Peak 1 in Figure 27) is shown in Figure 30. The differences shown in Figure 30 are calculated by taking the difference of the two instantaneous water levels shown in Figure 28 and Figure 29. The diversion discharge simulated at this time was ~71,700 cfs and the increase in WSE across the area was between 0.5 and 1.5 ft. The model simulated a large impact area for this event. The areas surrounding the communities would expect to see an increase of water level by 0.5 to 1 ft. Though the extents of WSE differences are like those seen for a week in May (Figure 26), the absolute differences in elevation are quite different for the single event and the week-long average.

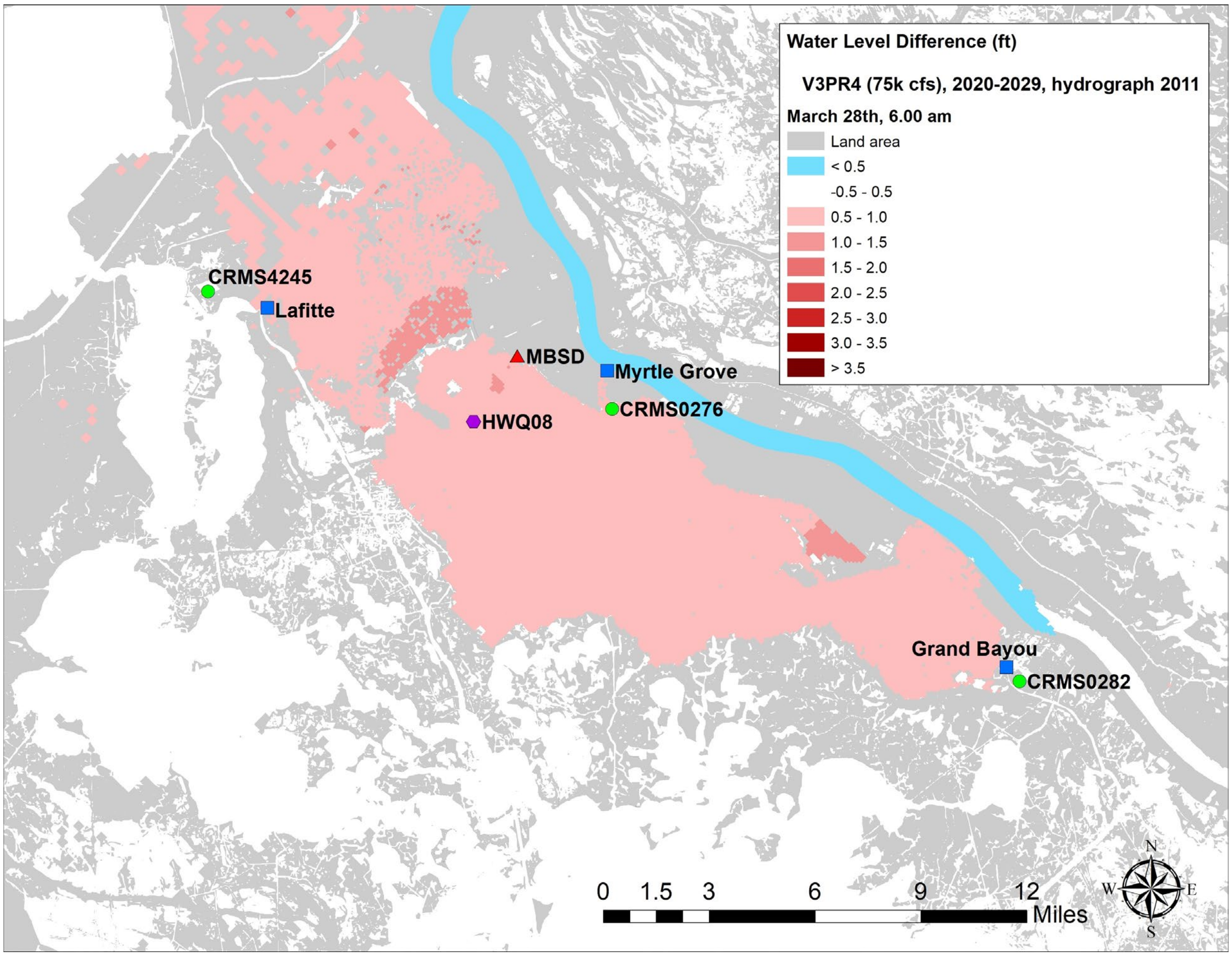


Figure 30: Difference in instantaneous WSEs for FWOP (V3PR1) and FWP (V3PR4, 75k cfs) during a wind driven peak event during the 2020s, on March 28th, 2011 at 6 am.

The WSE difference between the FWP 75k cfs and FWOP on April 28, 2011 at 6 pm (Peak 2 in Figure 27) is shown in Figure 31. The diversion discharge simulated at this time was ~65,900 cfs and the average increase in WSE across the area was between 0.5 and 1 ft. Unlike the peak of March 28th, the diversion did not significantly impact the WSEs near the three communities, rather most of the WSE increases are concentrated at the outlet of the diversion.

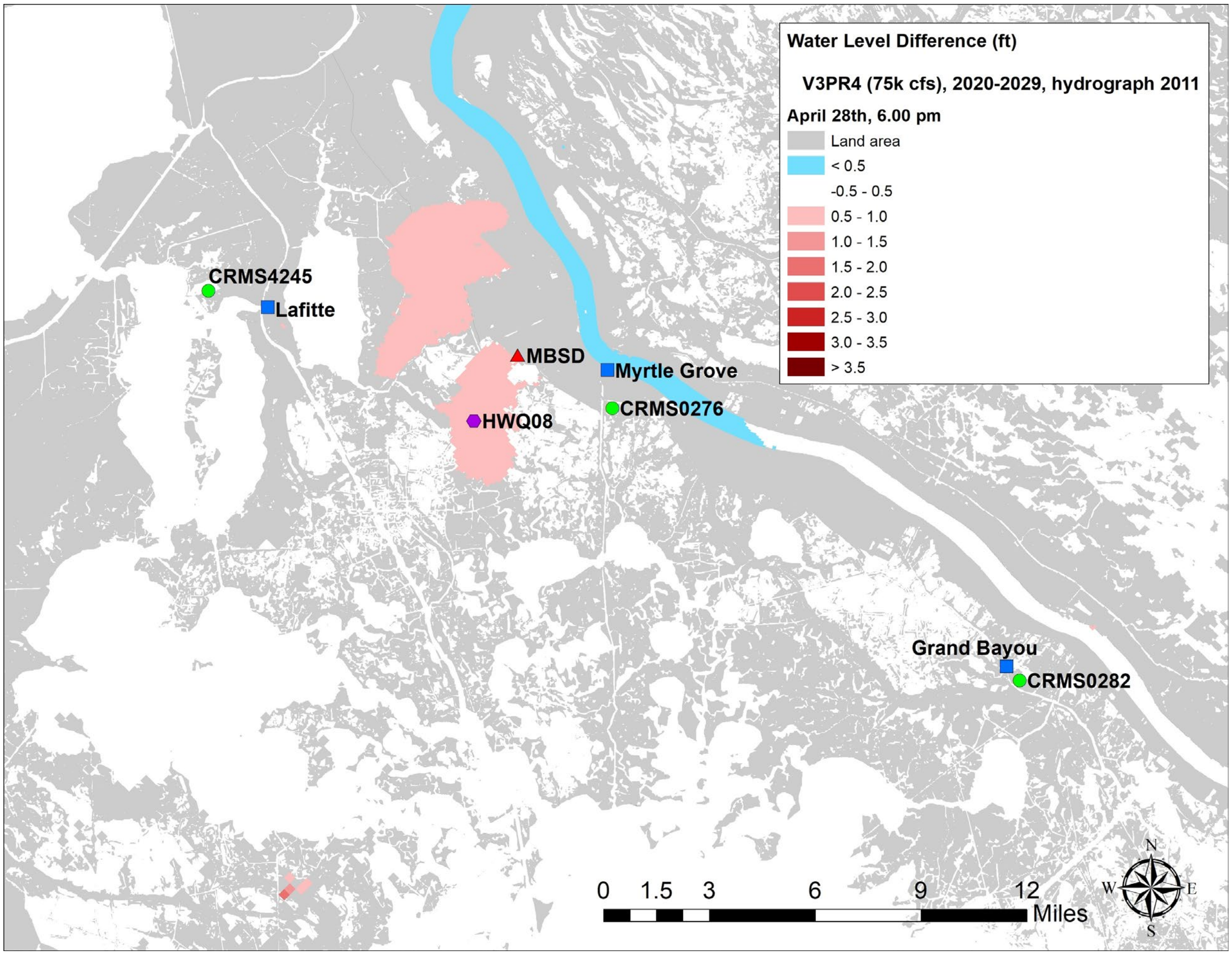


Figure 31: Difference in instantaneous WSEs for FWOP (V3PR1) and FWP (V3PR4, 75k cfs) during a wind driven peak event during the 2020s, 2011 hydrograph on April 28th, 2011 at 6 pm.

The spatial extent and vertical difference of WSE for the peak of May 12th at noon (Peak 3 in Figure 27) when the diversion was operating at 75,000 cfs is shown in Figure 32. The WSE difference varies between 0.5 and 1.5ft near the diversion outlet. The Myrtle Grove area is predicted to experience a change in WSE while the other communities are not impacted.

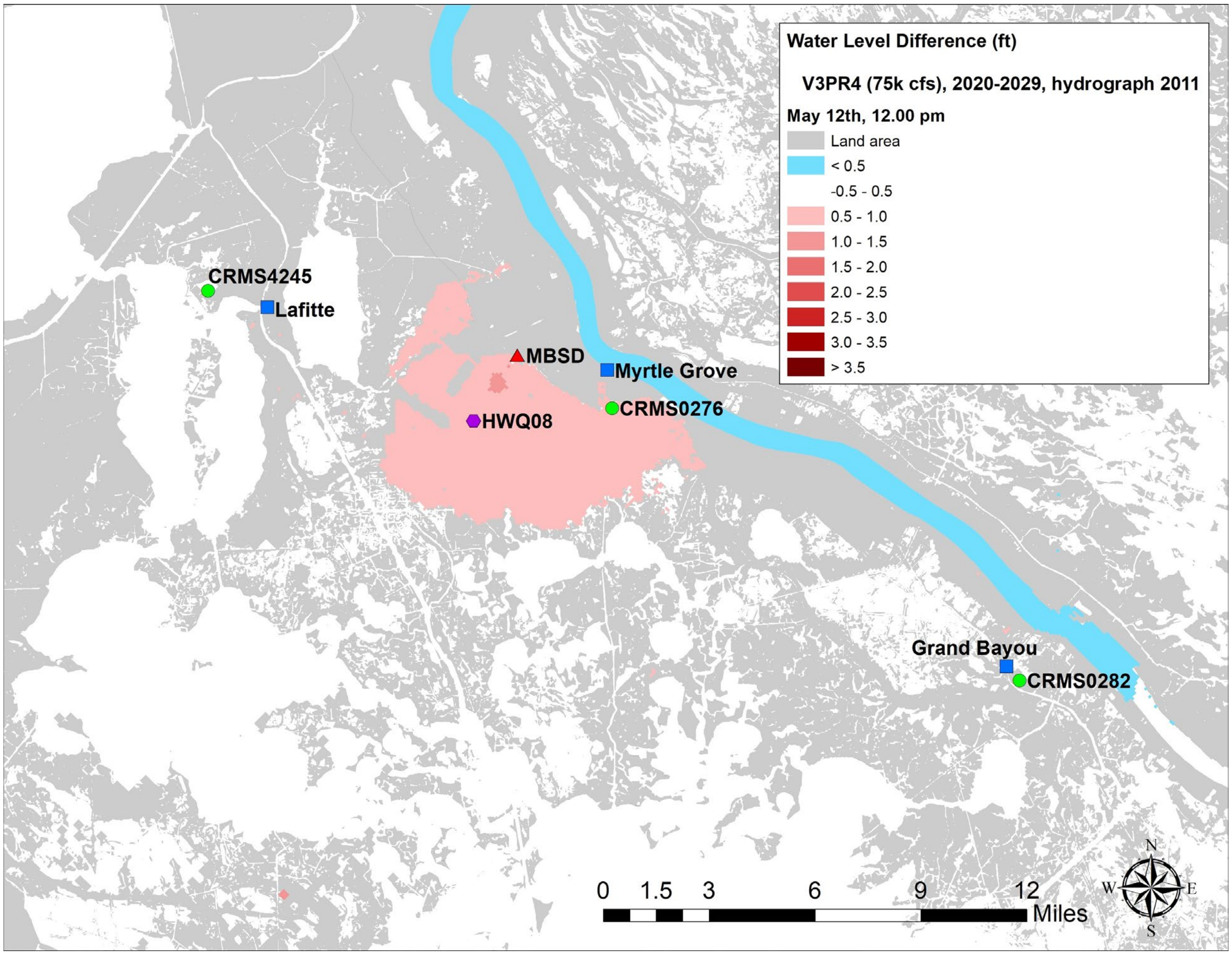


Figure 32: Difference in instantaneous WSEs for FWOP (V3PR1) and FWP (V3PR4, 75k cfs) during a wind driven peak event during the 2020s, on May 12th, 2011 at noon.

The variability in water level extent between the three peak events can be attributed to the wind direction and intensity, as well as the MBSD operations during each peak. Additional analysis would be required to better understand the physical processes that dominated during these events. Overall, this analysis of instantaneous water levels shows that when the WSEs in the basin are high due to weather related events, the impact of the MBSD operation will vary spatially. However, for the three peaks analyzed, the vertical increases in water level between the FWP and FWOP are generally 0.5 to 1 foot.

Mississippi River Hydrograph Sensitivity Analysis

Figure 33 to Figure 35 show the effect of different Mississippi River hydrographs (i.e., 1994, 2006, 2010 and 2011) on exceedance rates for each of the three communities for FWP scenarios. As a reference, the upper figure indicates the FWOP results for the 2011 Mississippi River hydrograph. In general, the results are for hydrographs 1994, 2010 and 2011 do not show large variations in exceedance rates, especially in the medium and long-term. Exceedance rates generally do not differ more than 25% from each other in the 2020s. The 2006 hydrograph represents a dry year with a relatively low Mississippi river discharge. This causes the diversion to be operated for a much shorter period and leads to lower exceedance rates for the short-term and to a lesser extent the medium-term. These differences are mostly eliminated by the 2040s due to the diminishing influence of the diversion on exceedance rates because of RSLR.

Figure 33 shows that the FWP threshold exceedance frequency at Myrtle Grove can vary as widely as a factor of three due to the Mississippi River discharge (and associated diversion discharge). This is highlighted by the comparison of the 2006 FWP and 2011 FWP threshold exceedances. However, the sensitivity of the frequency of exceedance related to Mississippi River discharge for FWP conditions diminishes in later decades due to RSLR and has a limited impact by the 2050s.

Because of the distance from the diversion and relatively high WSE exceedance threshold, the exceedance frequency near Lafitte (Figure 34) is less sensitive to the selection of the Mississippi River discharge than Myrtle Grove. Threshold exceedance at Lafitte is most sensitive to Mississippi River and diversion discharge in the 2040s, with the sensitivity diminishing after the 2040s.

Due to the relatively low threshold exceedance elevation, Grand Bayou (Figure 35) is sensitive to the selection of a Mississippi River discharge in the 2020s and 2030s. Because of its distance from the diversion itself, Grand Bayou is less sensitive than Myrtle Grove, though still shows a notable sensitivity (the threshold exceedance frequency can vary by a factor of 2 due to the Mississippi River discharge). Like Myrtle Grove however, the sensitivity of the frequency of exceedance related to Mississippi River discharge for FWP conditions diminishes in later decades due to RSLR and has a limited impact as early as the 2040s.

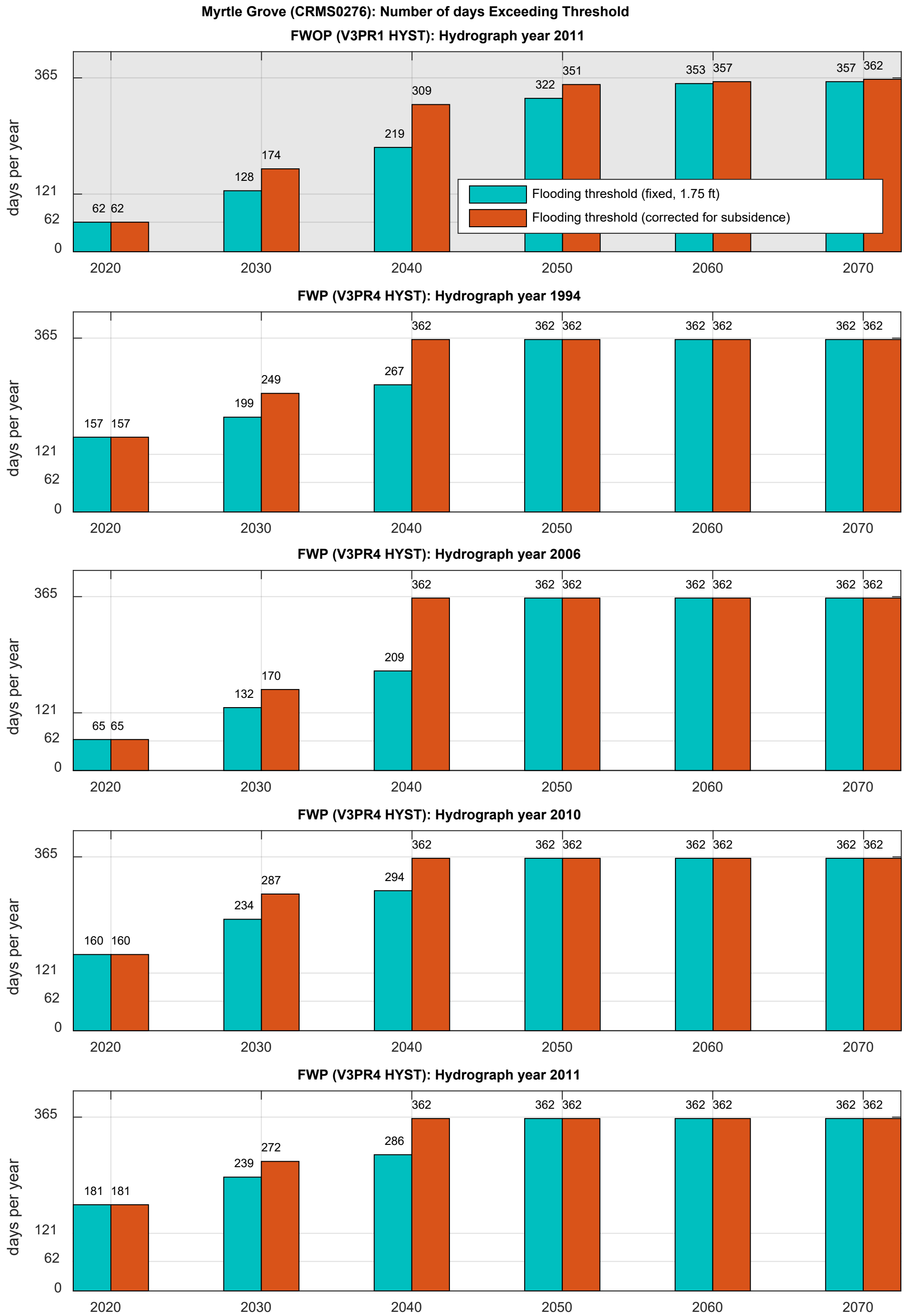


Figure 33: Analysis of the threshold exceedance rates in Myrtle Grove over time. Number of days exceeding the fixed WSE threshold elevation (green) and the corrected threshold elevation (orange). The figure consists of the 2011 FWOP results for reference (grey background) and the 1994, 2006, 2010 and 2011 FWP results (white background).

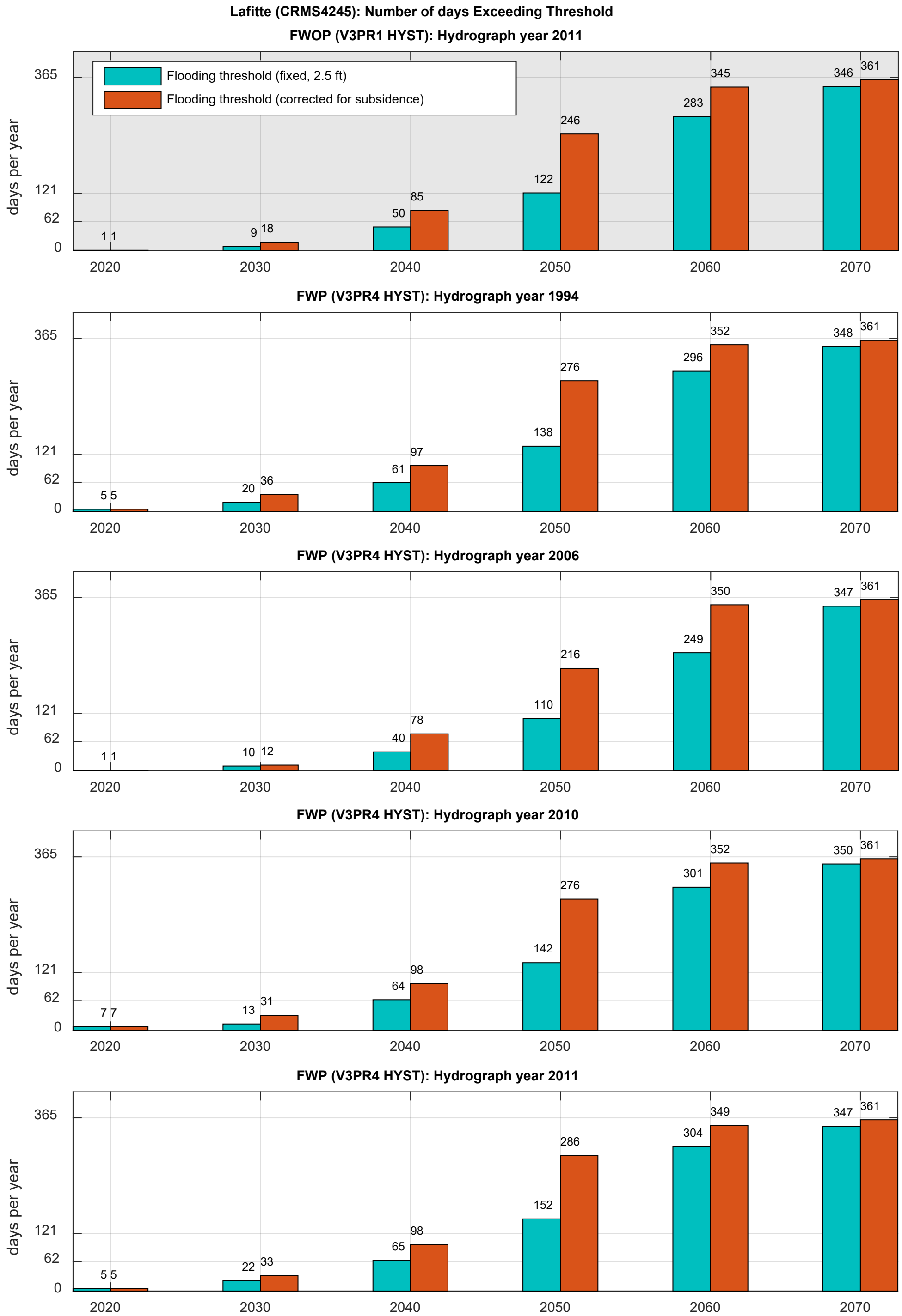


Figure 34: Analysis of the threshold exceedance rates in Lafitte over time. Number of days exceeding the fixed WSE threshold elevation (green) and the corrected threshold elevation (orange). The figure consists of the 2011 FWOP results for reference (grey background) and the 1994, 2006, 2010 and 2011 FWP results (white background).

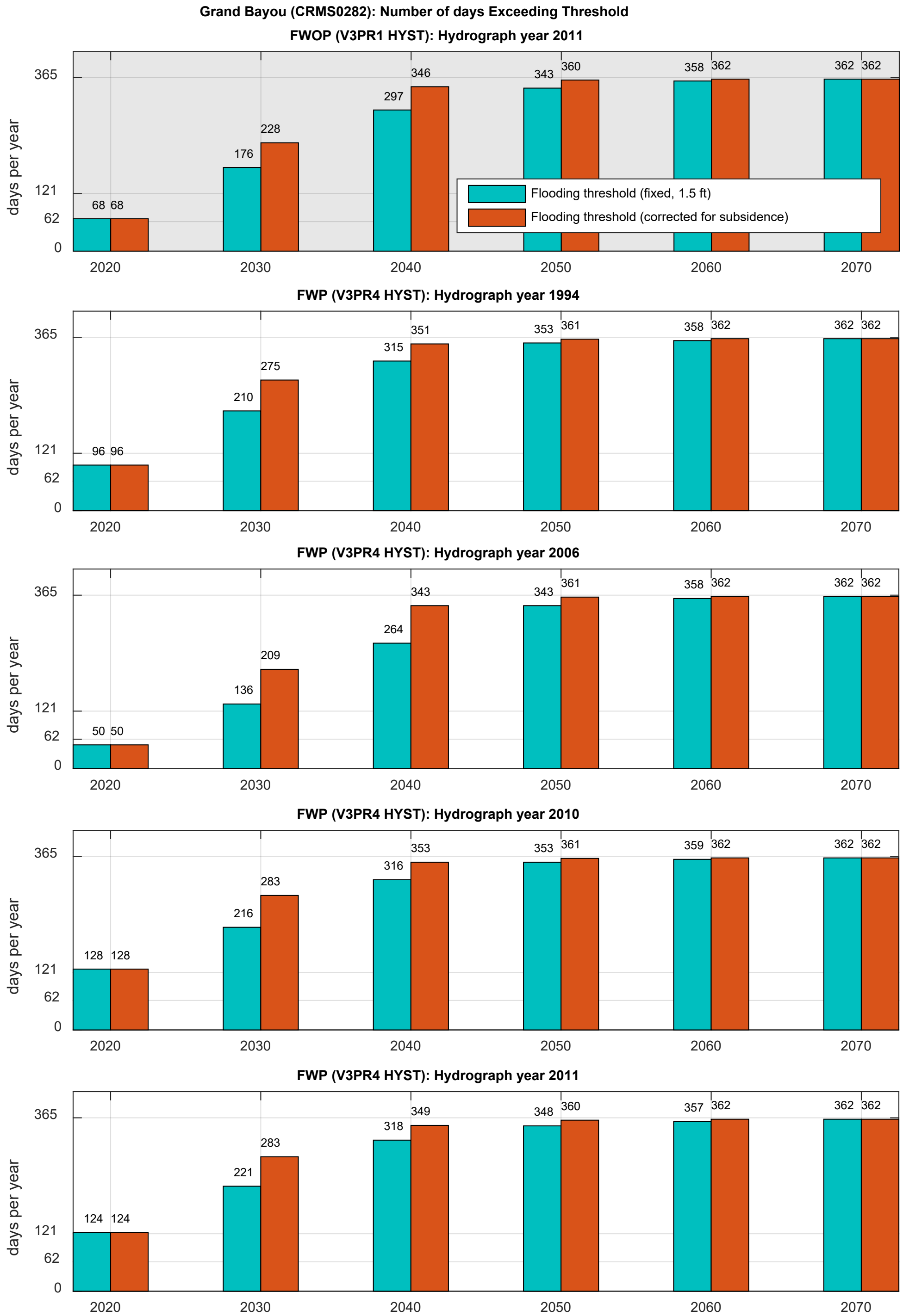


Figure 35: Analysis of the threshold exceedance rates in Grand Bayou over time. Number of days exceeding the fixed WSE threshold elevation (green) and the corrected threshold elevation (orange). The figure consists of the 2011 FWOP results for reference (grey background) and the 1994, 2006, 2010 and 2011 FWP results (white background).

Conclusions

The Delft3D Basinwide V3 model simulation results have been analyzed to compare modeled WSEs to WSE thresholds defined as a proxy for nuisance flooding potential.

The frequency and trends of WSEs over time were analyzed for FWOP conditions, to assess the impact of ESLR and subsidence on threshold exceedance at three nearby communities.

- The results show that Myrtle Grove will experience threshold exceedances during 15-20% of the days of the year by the 2020s, 30% by the 2030s and 60% by the 2040s. The community experiences near-continuous WSE threshold exceedance throughout the months May to October during the 2040s and nearly daily in the 2050s and later.
- The Lafitte community, due to its higher WSE threshold elevation, demonstrates a relatively lower vulnerability. Lafitte will experience infrequent high-WSEs that exceed the threshold during the 2020s and on the order of multiple weeks of threshold exceedance in the 2030s. By the 2050s and after, threshold exceedance is more substantial with exceedances surpassing 120 days annually during the 2050s and over 280 days annually in the 2060s.
- The community of Grand Bayou is predicted to be highly vulnerable to an increase in WSEs due to ESLR. Threshold exceedances are expected to occur during approximately 20% of the days in the 2020s and nearly half of the days in the 2030s, and throughout the year independent of season in the 2040s and later.

The second step of this analysis was to evaluate the effect of the MBSD on WSEs at the three community locations. The FWOP and FWP Applicant Preferred Alternative were compared over the 50-yr period to evaluate the effect of the diversion on water levels. For this analysis, the 2011 Mississippi River hydrograph was considered.

- During the first decade (2020s):
  - The WSE near Myrtle Grove was predicted to increase up to 1.3 ft more than the FWOP values causing the frequency of daily threshold exceedance to be 3 to 5 time higher than FWOP during the months of operation, and overall to triple on a yearly basis.
  - The effect of the diversion on water levels near Lafitte is insignificant, increasing up to 0.3 ft, but not substantially impacting the number of days of WSEs exceeding the defined threshold.
  - The WSE in Grand Bayou was predicted to increase up to 0.5 ft. The frequency of threshold exceedance increases by approximately a factor of 2 to 5 compared to FWOP during the months of operation and doubling in frequency if the entire year is considered.
  - Overall, the diversion impacts on WSE and on the frequency of threshold exceedance for Myrtle Grove and Grand Bayou are most significant in the short term.
- During the third decade (2040s):
  - Myrtle Grove appears to be the only community which was still predominately affected by the diversion operation, rather than predominantly impacted by RSLR. The water level increases up to 0.9 ft during diversion operation because of the community’s proximity to the MBSD.

- High water levels that occurred at Grand Bayou (+0.3 ft) and Lafitte (+0.3 ft) due to the MBSD have limited impact on WSE threshold exceedance.
    - The frequency of days exceeding the threshold did not significantly change between FWOP and FWP for Grand Bayou.
    - The medium-term period is when Lafitte community experiences the most significant impact from the diversion, showing approximately a 20% increase in exceedance frequency when the diversion is in operation, which results in around 15 additional days of threshold exceedance annually.
- During the final decade (2060s):
    - The ESLR was predicted to become the dominant factor causing WSE threshold exceedance in each of the three communities.
    - Both the FWOP and FWP results showed frequent threshold exceedance for all three communities.

A spatial analysis of the average water level difference between the FWP and FWOP also shows that at times when the MBSD is operating at maximum discharge, the impact of the diversion on water level is concentrated spatially around the area adjacent to the outfall and extends south and east, up to the proximity of Grand Bayou community. When the diversion is operating at full capacity, the maximum water level differences are 2 to 3 ft next to the diversion channel, up to 1.5 feet near Myrtle Grove, and less than 1 ft near Lafitte and Grand Bayou and in outer portions of the basin. During a WSE peak event (e.g., due to wind), the spatial extent and water level difference will vary, but the WSE increase (FWP less FWOP) due to the diversion was consistently less than 1.5 ft for the three events examined. The extent of the WSE differences is similar for the week-long average and the peak events, whereas the absolute difference of the water levels varies because the peak events are wind-driven, and the week-long averages reflect mostly impacts from the diversion operating at full capacity.

To better understand the sensitivity of the water level results to subsidence and variations in the Mississippi river discharge, additional analyses were conducted by adjusting the exceedance threshold over time to account for subsidence and assessing model outputs based on a broader set of hydrograph timeseries (i.e., 1994, 2006, 2010, and 2011).

- Analysis of the impact of subsidence demonstrated that the already vulnerable communities are notably more vulnerable when considering subsidence as part of the threshold exceedance elevations. In some cases, monthly and annual averaged WSEs are exceeding the thresholds 5 to 10 years earlier when the thresholds are adjusted to account for subsidence.
- There are no significant differences in the frequency of threshold exceedances across the 1994, 2010 and 2011 hydrograph timeseries which represented wet and average Mississippi River discharge conditions. However, the results are sensitive when compared to the 2006 hydrograph, which represents a low discharge year. Because the MBSD discharge is relatively low in a dry year like 2006, the frequency of threshold exceedance is lower for the communities. It should be noted however that though the absolute number of threshold exceedances can change in dry years, the trends in a broader sense remain the same for all three communities as it relates to increasing vulnerability with time due to RSLR.

Overall, the analyses within the report show that the communities will experience threshold exceedances as RSLR increases over the 50-year period. In the final decade, RSLR will be the main cause of high-water levels at the community regardless of the operation of the diversion. In the short term, Grand Bayou and Myrtle Grove are most impacted by diversion operation, with Lafitte most impacted in the medium-term.

References

Arcadis, 2019, Surge and wave conditions utilizing the traditional [and hysteresis] sediment rating curve

Brown Cunningham Gannuch, July 2002, 100% Design Report For Rosethorn Basin Flood Protection Project Jefferson Parish, Louisiana Volume I

CPRA, 2018, Lafitte Area Protection Projects Board Meeting

Esposito, Christopher R., Man Liang, and Ehab A. Meselhe, 2017, TO05 Outfall Management Report: Mid-Barataria and Mid-Breton Diversions. The Water Institute of the Gulf. Funded by the Coastal Protection and Restoration Authority under Task Order 05.

Liang, Man, Ehab A. Meselhe, Francesca Messina, and Collin Ortals, 2016, TO41 Riverside Diversion Optimazation. Baton Rouge, LA: The Water Institute of the Gulf. Funded by the Coastal Protection and Restoration Authority under Task Order 41.

Meselhe, E., E. D. White, and D. J. Reed, 2017, 2017 Coastal Master Plan: Appendix C: Modeling Chapter 2 – Future Scenarios. Baton Rouge, Louisiana: Coastal Protection and Restoration Authority. http://coastal.la.gov/wp-content/uploads/2017/04/Appendix-C_chapter2_FINAL_3.16.2017.pdf, accessed May 24, 2017.

Meselhe, Ehab A., and Mallory Davis Rodrigue. 2013, Models Performance Assessment Metrics and Uncertainty Analysis. Louisiana Coastal Area Program Mississippi River Hydrodynamics and Delta Management Study. Baton Rouge, LA: Louisiana Coastal Area Program.

Meselhe, Ehab A., Kazi Sadid, Francesca Messina, and Hoonshin Jung, 2017, TO46: Basin-Wide Delft3D Run for Evaluation of Diversion Operations (Production Run11-15). Baton Rouge, LA: The Water Institute of the Gulf. Funded by the Coastal Protection and Restoration Authority under Task Order 36.

Meselhe, Ehab, M.M Baustian, and A. Mead, 2015, Basin Wide Model Development for the Louisiana Coastal Area Mississippi River Hydrodynamic and Delta Management Study. Baton Rouge, LA.: The Water Institute of the Gulf. Funded by the Coastal Protection and Restoration Authority under Task Order 27.1.

Sadid, Kazi, Francesca Messina, Hoonshin Jung, Brendan Yuill, and Ehab Meselhe, 2018.Basinwide Model Version 3: Basinwide Model for Mid-Breton Sediment Diversion Modeling. Baton Rouge, LA: The Water Institute of the Gulf. Funded by the Coastal Protection and Restoration Authority.

Sweet V. William, Greg Dusek, Jayantha Obeysekera, John J. Marra 2018 NOAA Technical Report NOS CO-OPS 086. Patterns and Projections of High Tide Flooding Along the U.S. Coastline Using a Common Impact Threshold

Appendix A – Supporting Data for Tidal Flooding Thresholds and Ancillary Data Sources

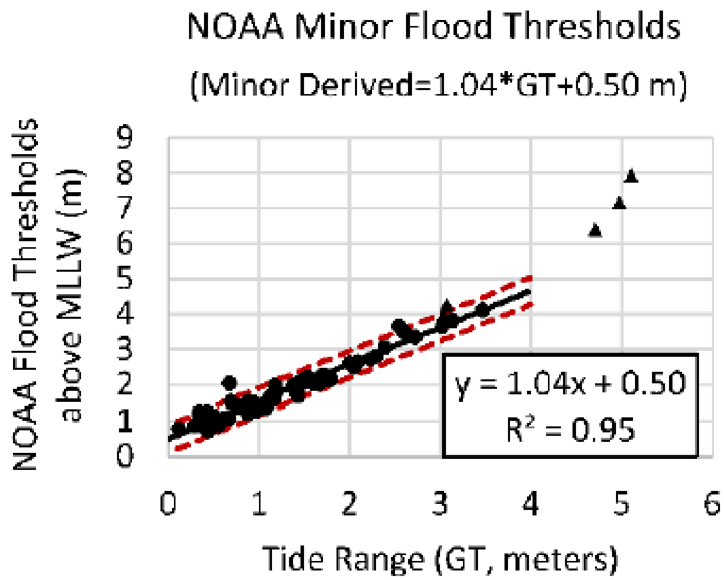


Figure A 1. Scatter plot of NOAA tide gauge locations with official NOAA coastal flood thresholds (y-axis) shown relative to MLLW tidal datum for minor impacts and the diurnal tide range (GT). Linear regression fits (black line and boxed equation) and 5%-95% confidence interval (red dashed lines) are obtained by solving the regression equation for a particular location. For example, the minor flood threshold at Grand Isle is 1.04*x (local GT) +0.51. The Great Diurnal Range (GT= Mean Higher High Water – Mean Lower Low Water) at Lafitte is estimated to be approximately 0.30 m and the minor flood threshold calculated according the NOAA's guidance (equation valid at Grand Isle) is 0.8 m above Mean Lower Low Water MLLW. The conversion from the local tidal datum (MLLW) and geodetic datum (NAVD88) is estimated to be -0.10m ± 0.10 m and so the minor flood threshold is within the range 0.7 m ± 0.1 m (2.3 feet ± 0.3 feet) above NAVD88 datum. Source: Sweet et al. 2018

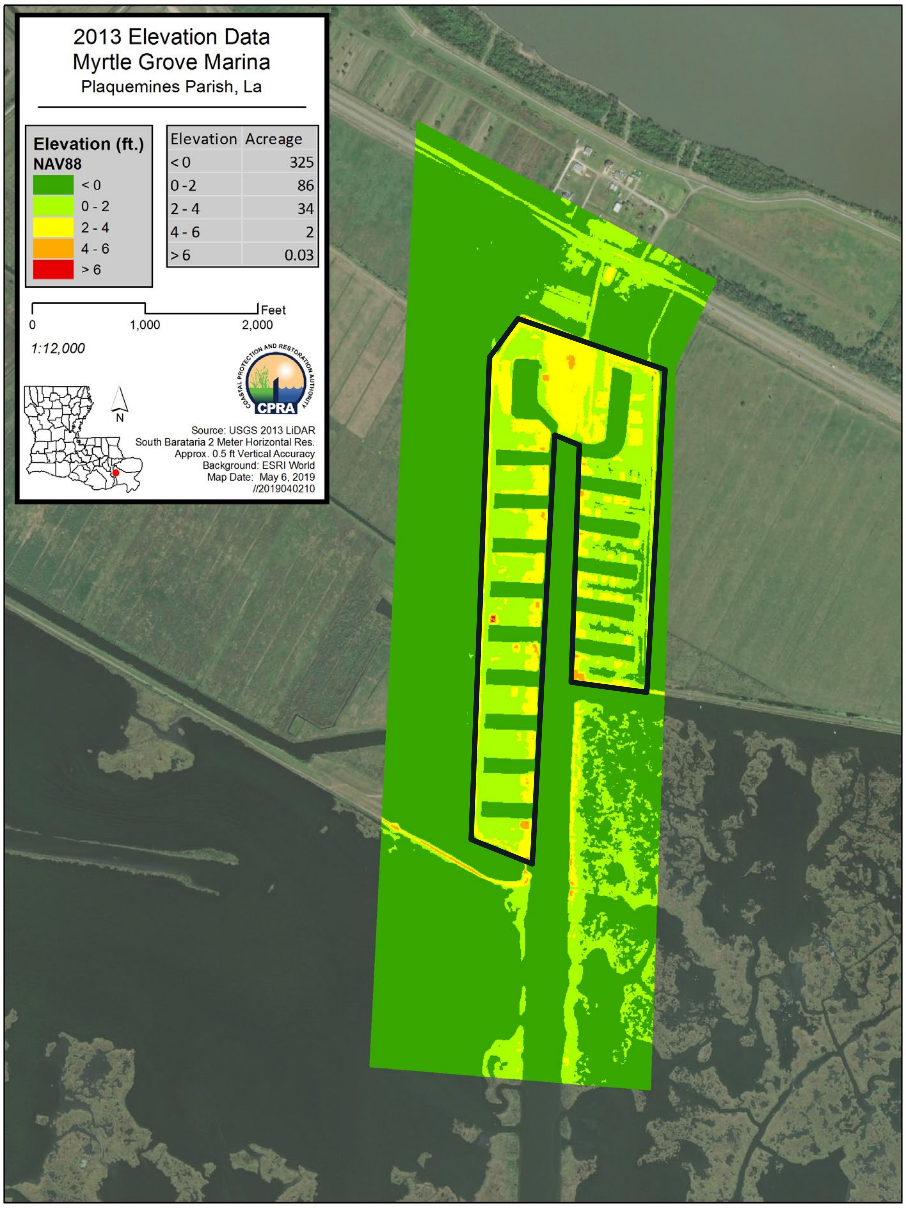


Figure A 2. USGS 2013 LiDAR (DEM) showing ground elevations at Myrtle Grove. The ground elevations within the area where the communities are located (black line) are largely in the range +0-2 ft NAVD88 (light green).

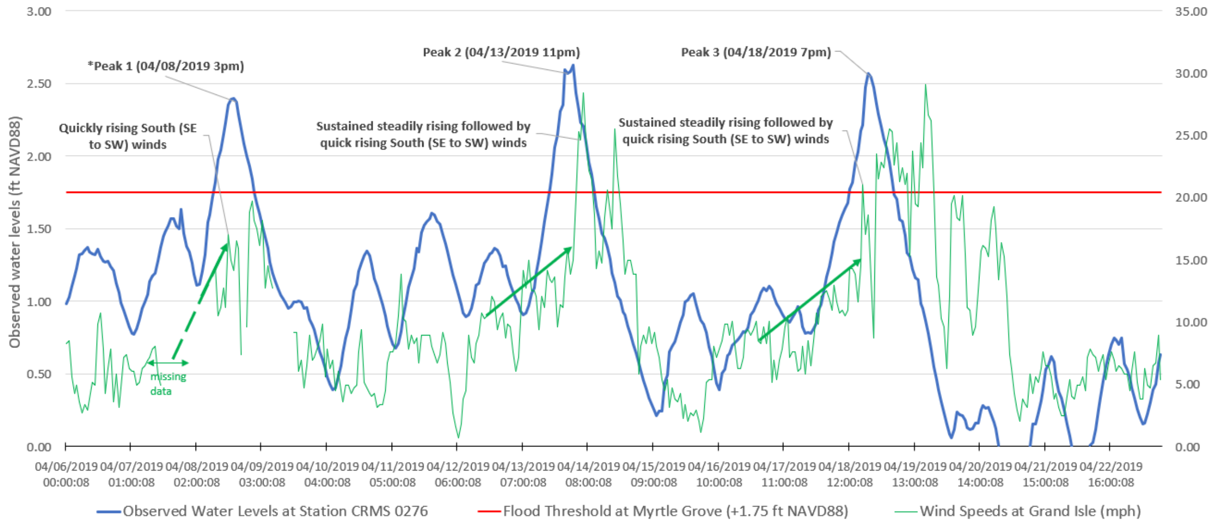


Figure A 3. Recent water level data at Myrtle Grove (Station CRMS0276) and wind speeds recorded at Grand Isle (Source NOAA) showing three wind tide peaks. *The first peak (April 8th) was a verification event when water levels were reported by the surveyor and CPRA personnel on site confirming +1.8-2.0 ft NAVD88. Site observation confirmed that flood threshold at +1.75 ft NAVD88 is appropriate to indicate initial flood event in this area.

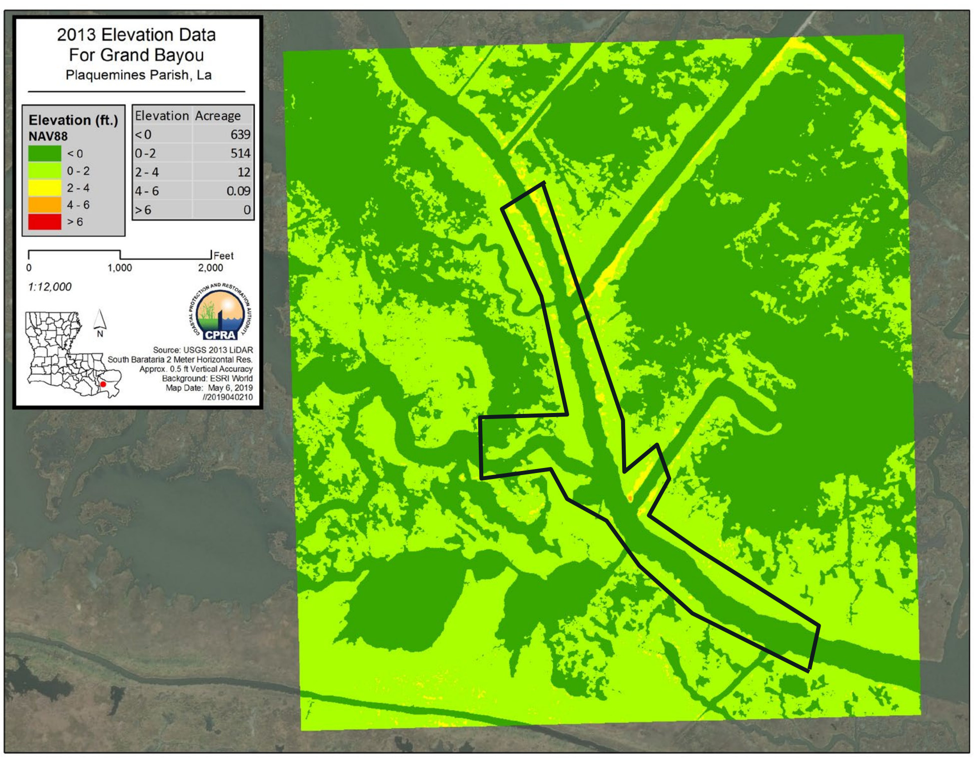


Figure A 4. USGS 2013 LiDAR (DEM) showing ground elevations at Grand Bayou and area (in black) where communities are located. The ground elevations within the populated area are largely in the range +0-2 ft NAVD88.

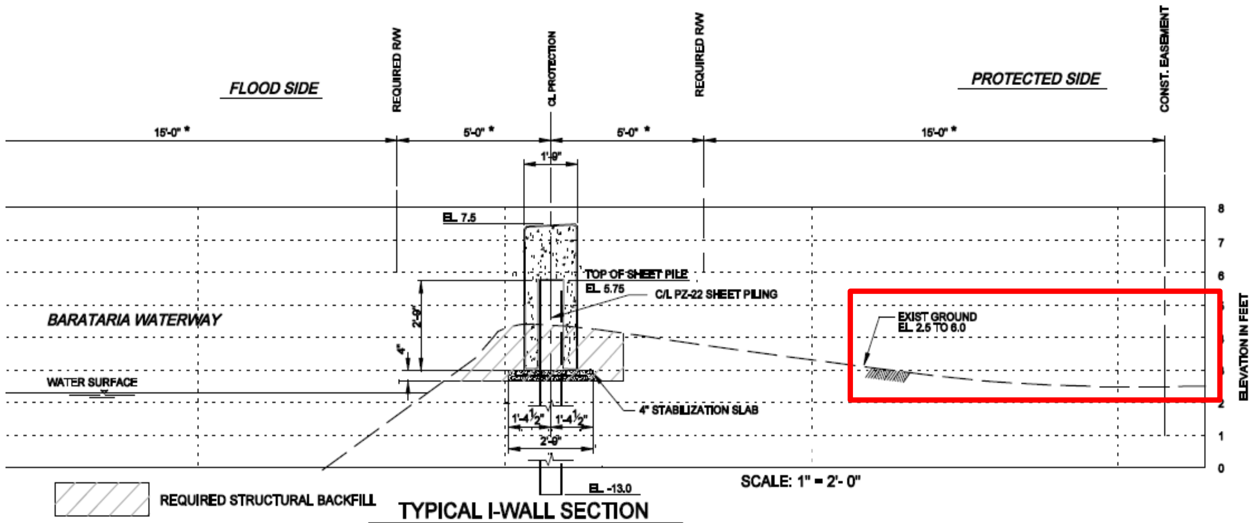


Figure A 5.1 Representative ground elevation of the Jean Lafitte tidal protection basin, indicating lower elevations subject to the onset of nuisance flooding, which correspond with approximately 2.5 ft (red frame).

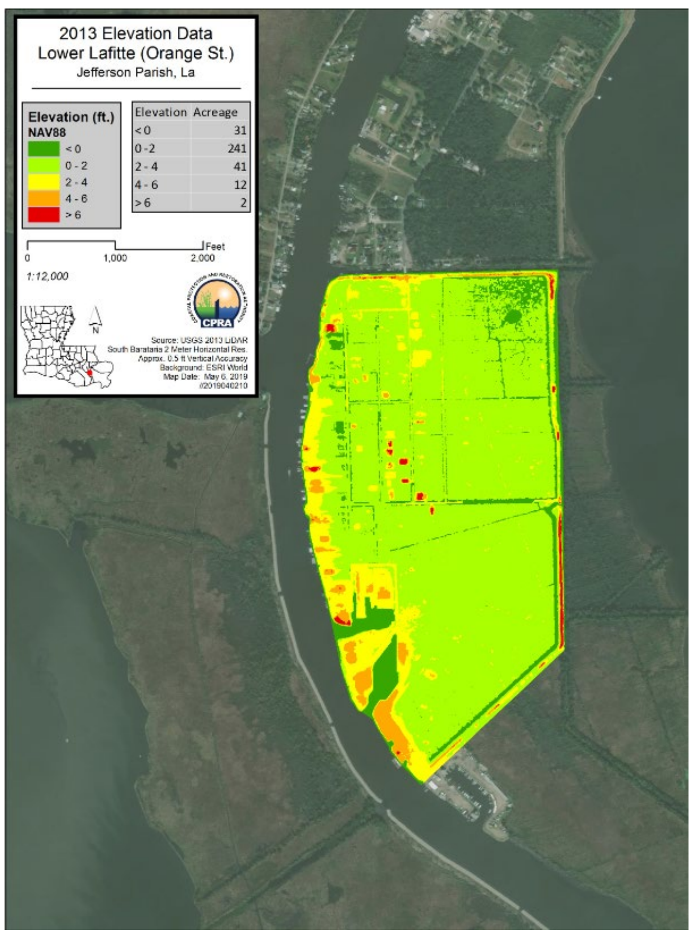
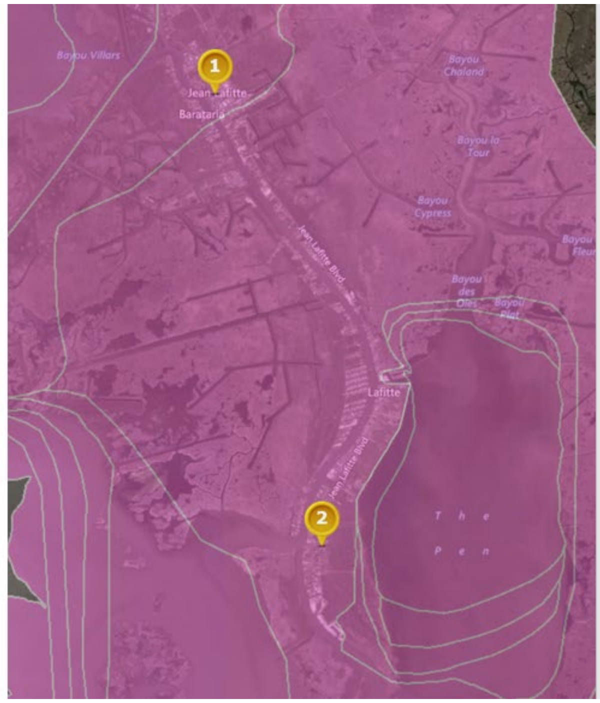


Figure A 5.2 USGS 2013 LiDAR (DEM) showing ground elevations at the Lower Lafitte basin. The ground elevations within the basin are largely in the range +0-2 ft NAVD88.

Jefferson Parish FIRM
Flood Impact Study 2016
FIRM effective Feb 2018

Jean Lafitte (1)
Zone AE
BFE = 8ft

Lafitte (2)
Zone AE
BFE = 9ft



Myrtle Grove FIRM
1985 & Preliminary

1985
Zone A16
BFE = 8 ft

Preliminary
Zone VE
BFE = 11-14 ft

Figure A 6. FEMA supporting data (Figure 1 of 2)

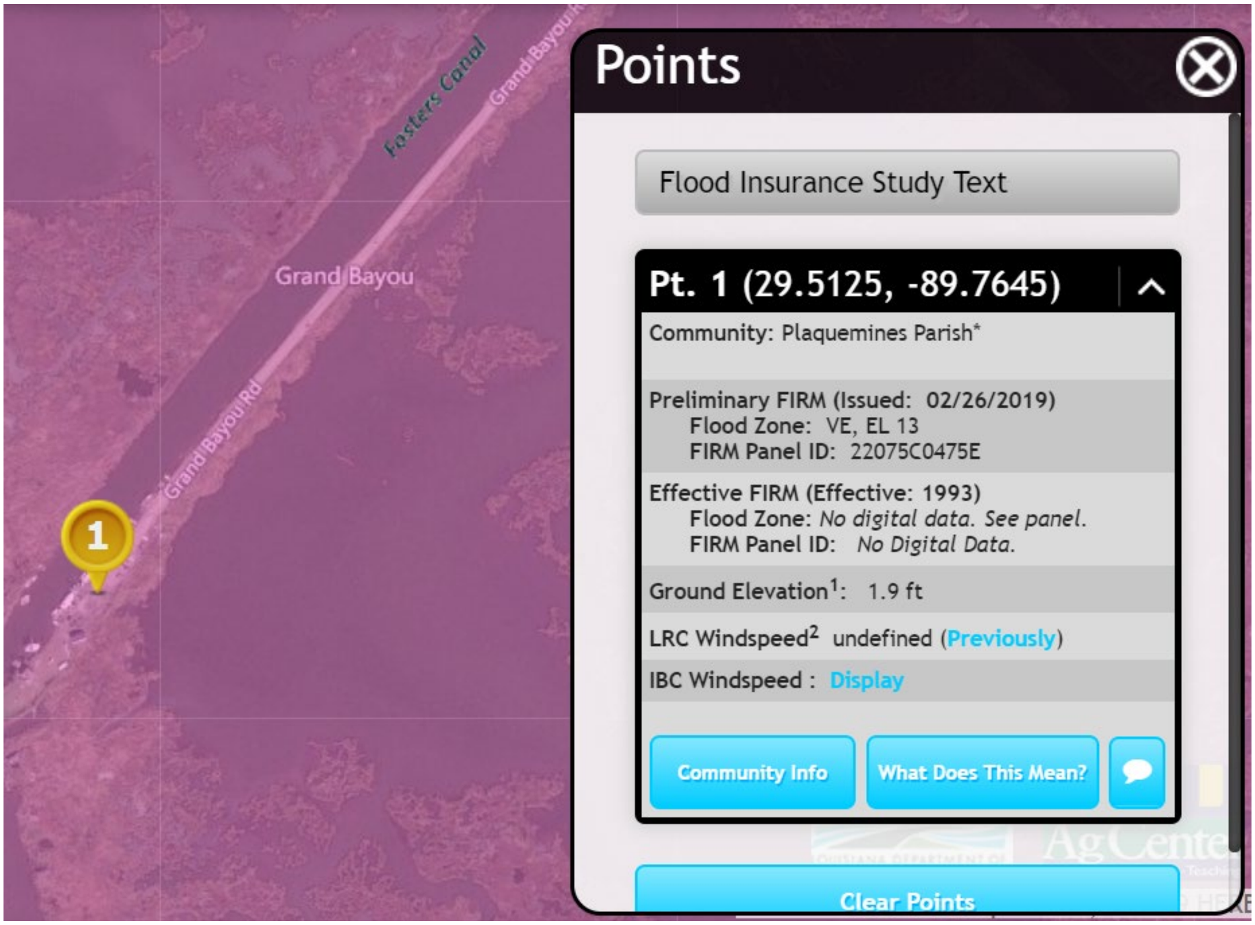


Figure A 7. FEMA supporting data (Figure 2 of 2) - [1]Ground Elevation is provided by USGS's elevation web service which provides the best available data for the point illustrated above.

Appendix B – Model Calibration, Setup and Performance

CALIBRATION AND VALIDATION OF BASINWIDE MODEL

For this analysis, Version 3 (V3) of the Basinwide model was used. The model was calibrated using year 2014 time series data, and validated using year 2016 time series data, during the period from March 1 to December 31 after a two-month model spin-up period. Detailed information about the model setup, the calibration and the validation can be found in the corresponding report (i.e., Sadid et al. 2018).

The 50-year simulations (Production Runs, PR) performed for the Mid-Barataria EIS-TPC include morphodynamic/sediment, hydrodynamic, vegetation and water quality simulations. For the specific analysis presented in this report, only the hydrodynamic simulations have been used. However, the landscape (i.e., bathymetry and roughness due to vegetation distribution) has been calculated based on the morphological changes, results of the morphodynamic/sediment simulations, and on the organic accumulation and vegetation distribution. It should be noted that the morphodynamic/sediment simulations require the sediment load as upstream boundary condition. This is calculated from the river water discharge, with a specific equation. In the set of simulations used in this analysis, the hysteresis rating curve developed by The Institute in 2016 has been used to calculate the fine sediment load (Liang et al. 2016). A traditional approach (direct function between water discharge and sediment load) has been used for the sand sediment load (Sadid et al. 2018). For this reason, the set of PRs used in this analysis has been called "HYST".

ATMOSPHERIC FORCING IN MODEL

For the Basinwide model V3, wind data covering the entire model domain were extracted from the National Oceanic and Atmospheric Administration (NOAA)-based Center for Environmental Prediction (ftp://ftp.cdc.noaa.gov/Datasets/ncep.reanalysis/pressure/). This dataset consists of a six-hour surface-wind direction and velocity at a spatial resolution of 1-degree. This dataset has been rescaled to a 10 km x 10 km grid and used in the Delft3D Basinwide model.

Daily precipitation data were obtained from the NOAA Center for Environmental Prediction database. Data available at 1-degree resolution were used to prepare the rescaled 10 km x 10 km spatial rainfall. Monthly average evaporation data were available from the International Water Management Institute's World Water and Climate Data Atlas (IWMI, 2014). The IWMI calculated potential Evapotranspiration (ET) via the Penman-Monteith method (Allen et al., 1998). The ET data were subtracted from the daily precipitation to specify the spatial excess rainfall boundary (Sadid et al. 2018).

For the calibration and validation simulation, the atmospheric forces of the corresponding years (i.e., 2014 and 2016) were used.

For the analysis presented in this report, a 50-year PR analysis has been used to simulate the landscape evolution and future environmental condition, without the presence of the MBSD (or FWOP) and with its presence (FWP). Four specific PRs have been used for this analysis: FWOP (V3PR1) and three FWP scenarios (V3PR2: 50k cfs, V3PR4: 75k cfs, and V3PR6: 150k cfs). Each PR covers a 50-year period (2020-2070), divided in 5 decades (also called cycles). Different Mississippi River hydrographs have been used for each decade. Because the future meteorological conditions are unknown, a common representative year has been used into the model. Specifically, 2014 meteorological conditions (e.g., wind field, rainfall, cloud coverage, etc.) have been used over the entire 50-year simulation, repeating the same year over and over.

MODEL PERFORMANCE

Figure B 1 to Figure B 6 show the results for the water level calibration and validation for the Basinwide model, V3. Water level observations (from CRMS stations) are reported as discrete points in the plot, the model outputs are reported as green line.

Table B 1 and Table B 2 present the V3 model performance in terms of bias, percent bias, root-mean-square error (RMSE), percent RMSE and correlation coefficient (Corr Coeff R) for three stations used in this analysis (Sadid et al. 2018; Meselhe and Rodrigue 2013). For each station, the table also report how well (poor, fair, or good) the model performs. The results have been established based on visual inspections of all the plots (Sadid et al. 2018).

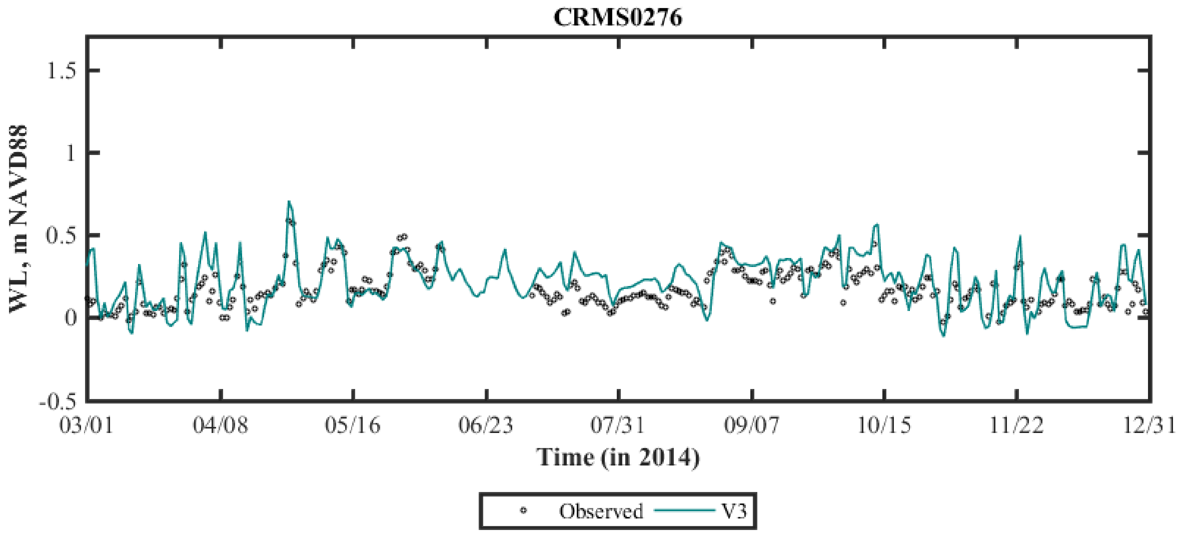


Figure B 1.V3 Basinwide model calibration of daily water level (WL) at CRMS0276 (Myrtle Grove community), in Barataria Basin (2014).

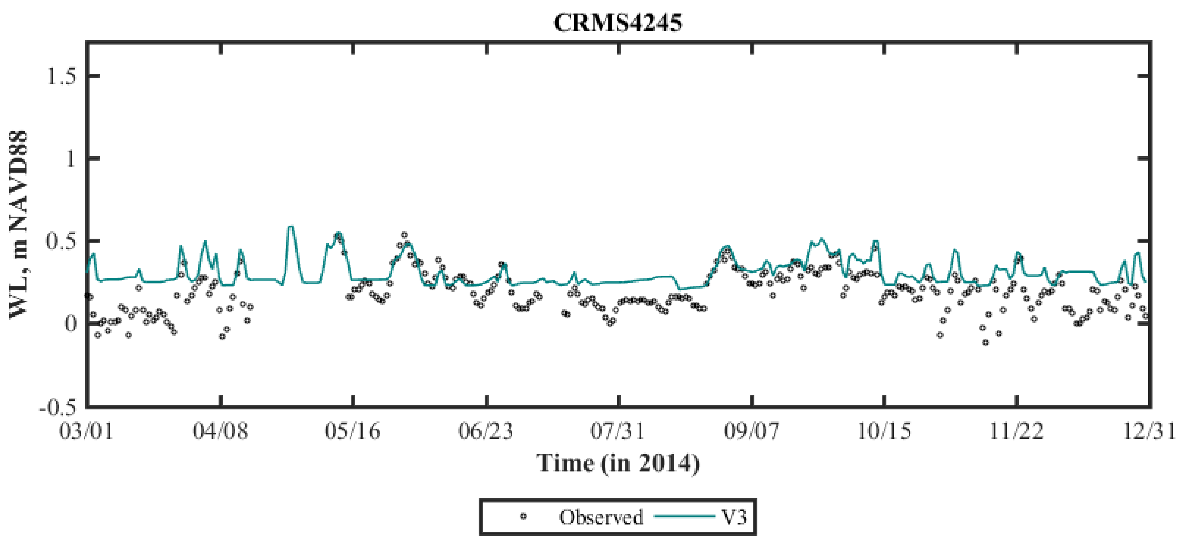


Figure B 2.V3 Basinwide model calibration of daily water level (WL) at CRMS4245 (Lafitte community), in Barataria Basin (2014).

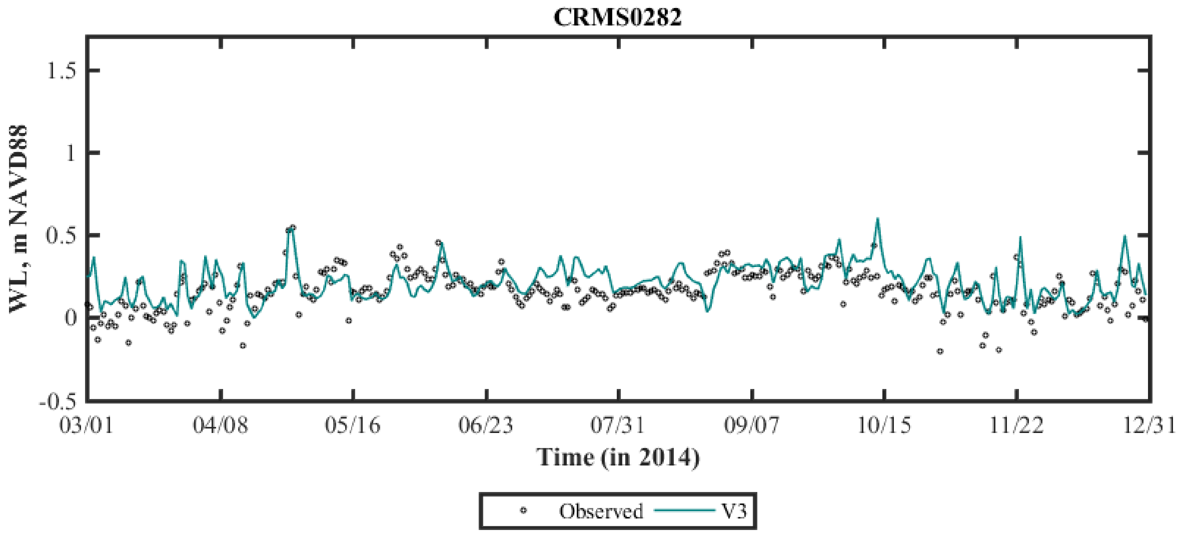


Figure B 3.V3 Basinwide model calibration of daily water level (WL) at CRMS0282 (Grand Bayou community), in Barataria Basin (2014).

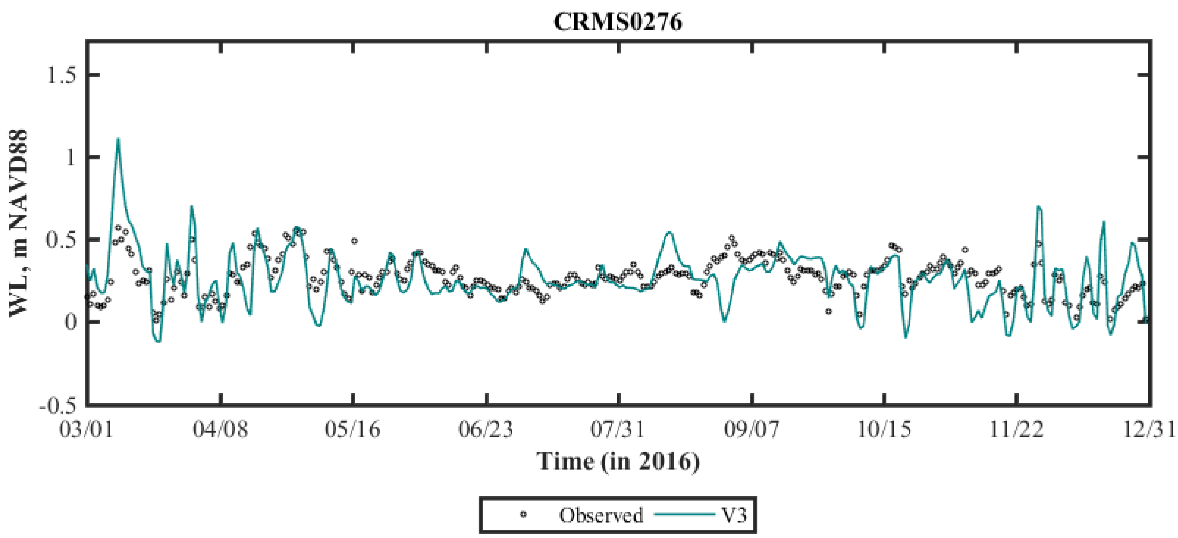


Figure B 4.V3 Basinwide model validation of daily water level (WL) at CRMS0276 (Myrtle Grove community), in Barataria Basin (2016).

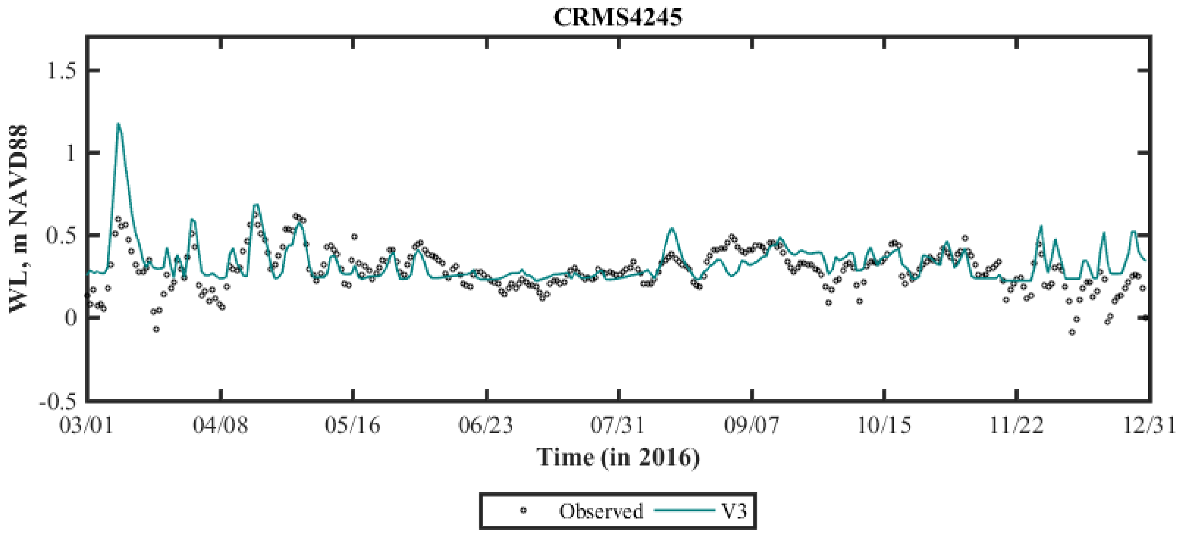


Figure B 5.V3 Basinwide model validation of daily water level (WL) at CRMS4245 (Lafitte community), in Barataria Basin (2016).

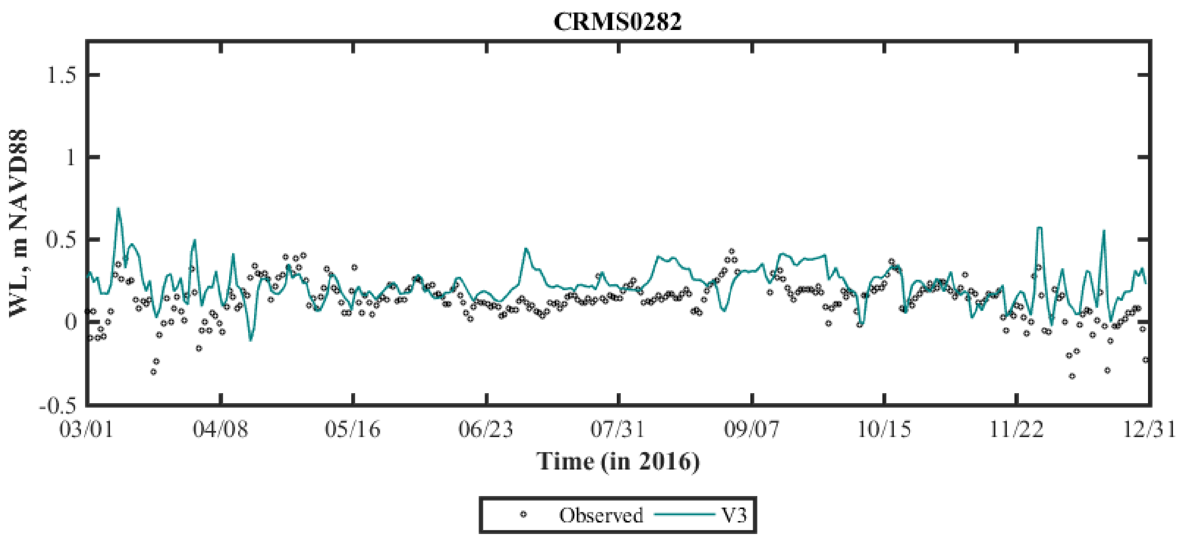


Figure B 6.V3 Basinwide model validation of daily water level (WL) at CRMS0282 (Grand Bayou community), in Barataria Basin (2016).

Table B 1.V3 Basinwide model calibration results for year 2014, water level.

Station ID	Water level V3 Model Performance - 2014						
	Bias	RMSE	Corr Coeff R	Bias	RMSE	Performance	Comment
	(m)	(m)	(-)	(%)	(%)		
CRMS0276	0.05	0.11	0.78	3	7	Good	
CRMS4245	0.11	0.15	0.66	7	9	Fair	The model bathymetry affects the lower water level fluctuations. The station is partially dry
CRMS0282	0.05	0.12	0.54	3	8	Good	

Table B 2.V3 Basinwide model validation results for year 2016, water level.

Station ID	Water level V3 Model Performance - 2016						
	Bias	RMSE	Corr Coeff R	Bias	RMSE	Performance	Comment
	(m)	(m)	(-)	(%)	(%)		
CRMS0276	**-0.01**	**0.13**	**0.62**	**0**	**8**	**Good**	
CRMS4245	0.04	0.12	0.57	2	8	Good	The model bathymetry affects the lower water level fluctuations. The station is partially dry
CRMS0282	0.09	0.16	0.31	6	11	Good	

When interpreting the results, please note that the model has a precision of +/- 0.1 feet (3 cm). Based on the water level statistical analysis presented above, it should be noted that:

- For CRMS0276: the model reproduces the observed high and low water level fluctuations very well;
- For CRMS4245: the relative elevation of the model bathymetry influences the model results. In particular, the lower water levels, which produce very small water depths, are often not well predicted. However, the high-water levels are well captured. Since the aim of the analysis presented in this report is to evaluate the peaks and the WSE threshold exceedances, the station is assumed suitable for the analysis;
- For CRMS0282: the model reproduces the observed water level data well.

As mentioned in the Basinwide model V3 calibration and validation report (Sadid et al. 2018), it should be noted that the data used as boundaries and atmospheric drivers were temporally-averaged over 6-hour intervals or greater. These times scales for the boundary conditions were selected due to limitations of data availability and the large spatial and temporal scales considered.

For the objective of this analysis, the model appears to reproduce both low and high-frequency water level fluctuations relatively well. However, it can be observed that the model slightly overestimates the water level of some high-frequency (storm-induced) events (e.g., Figure B 6 at the beginning of March). This is mostly the case during the first and last weeks of the timeseries depicted in Figure B 1 to Figure B 6. Therefore, the analysis presented in this report can be considered slightly conservative.

MODEL LIMITATIONS

The model resolution in the MBSD outfall proximity area is 125m. Two of the locations analyzed in this report fall in this area of the model domain. Lafitte, which is the furthest distance from the diversion, is located in an area where the model resolution is 375m. The land building pattern predicted by the model are expected to be realistic, but it should be kept in mind that the resolution of the land building detailed features (i.e., channels, splays, etc.) will be affected by the model resolution.

Moreover, the MBSD discharge in the model is prescribed by the user at the beginning of each simulation based on a specific relationship with the Mississippi River discharge. This relationship has been calculated during previous modelling efforts, by using a higher resolution model (Esposito, Liang, and Meselhe 2017).

The Basinwide model was not designed to fully resolve the complex tail-water effects (i.e., processes occurring in the outfall area do not directly impact diversion conveyance in the model). Even if sea level rise would typically reduce the head-difference and reduce the diversion capacity over time, the MBDS discharge in the Basinwide model was calculated and applied in the model in the same way for all 50 years, regardless of the head-difference reduction over time. As part of the model setup, an assumption has been made that any loss of diversion capacity would be compensated for during the diversion design and construction phase or through outfall management (mechanical removal of material).

Appendix C – 50k and 150k cfs alternatives

50K CFS (V3PR2) ALTERNATIVE

This section presents vertical and spatial water level analysis for alternative V3PR2 (50k cfs). A vertical analysis is presented comparing FWOP (V3PR1) with FWP V3PR2 over time.

Figure C 1 to Figure C 3 present the first decade (2020s) results (short-term analysis).
Figure C 4 to Figure C 6 present the third decade (2040s) results (medium-term analysis).
Figure C 7 to Figure C 9 present the fifth decade (2060s) results (long-term analysis).

A spatial analysis is also included to better understand how the diversion operating at fully capacity of 50k cfs would impact the WSE in the area relative the FWOP. The average water level difference for the first week of May is presented in Figure C 10.

Short-term

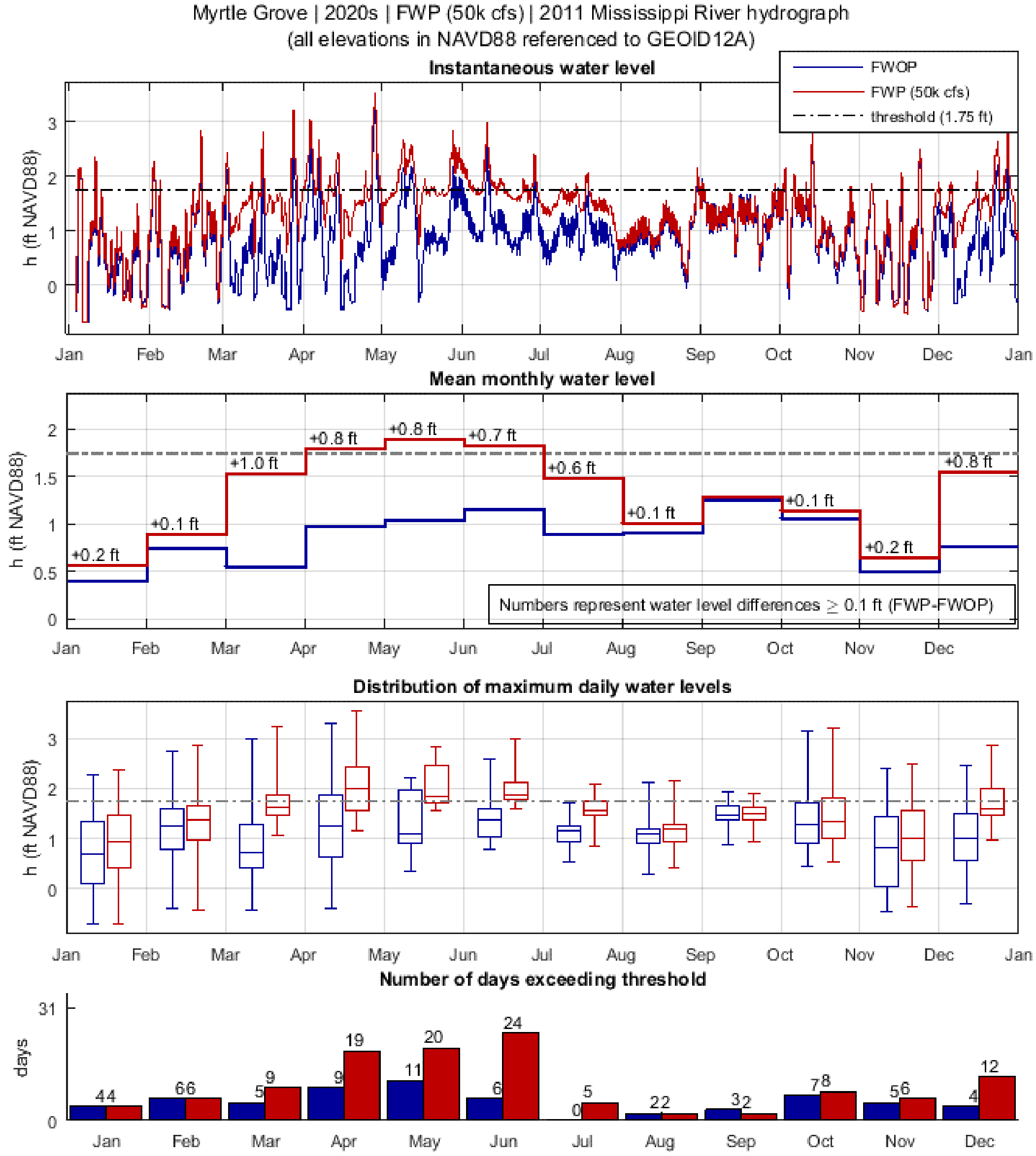


Figure C 1: Analysis of diversion impact on WSEs in Myrtle Grove during the 2020s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

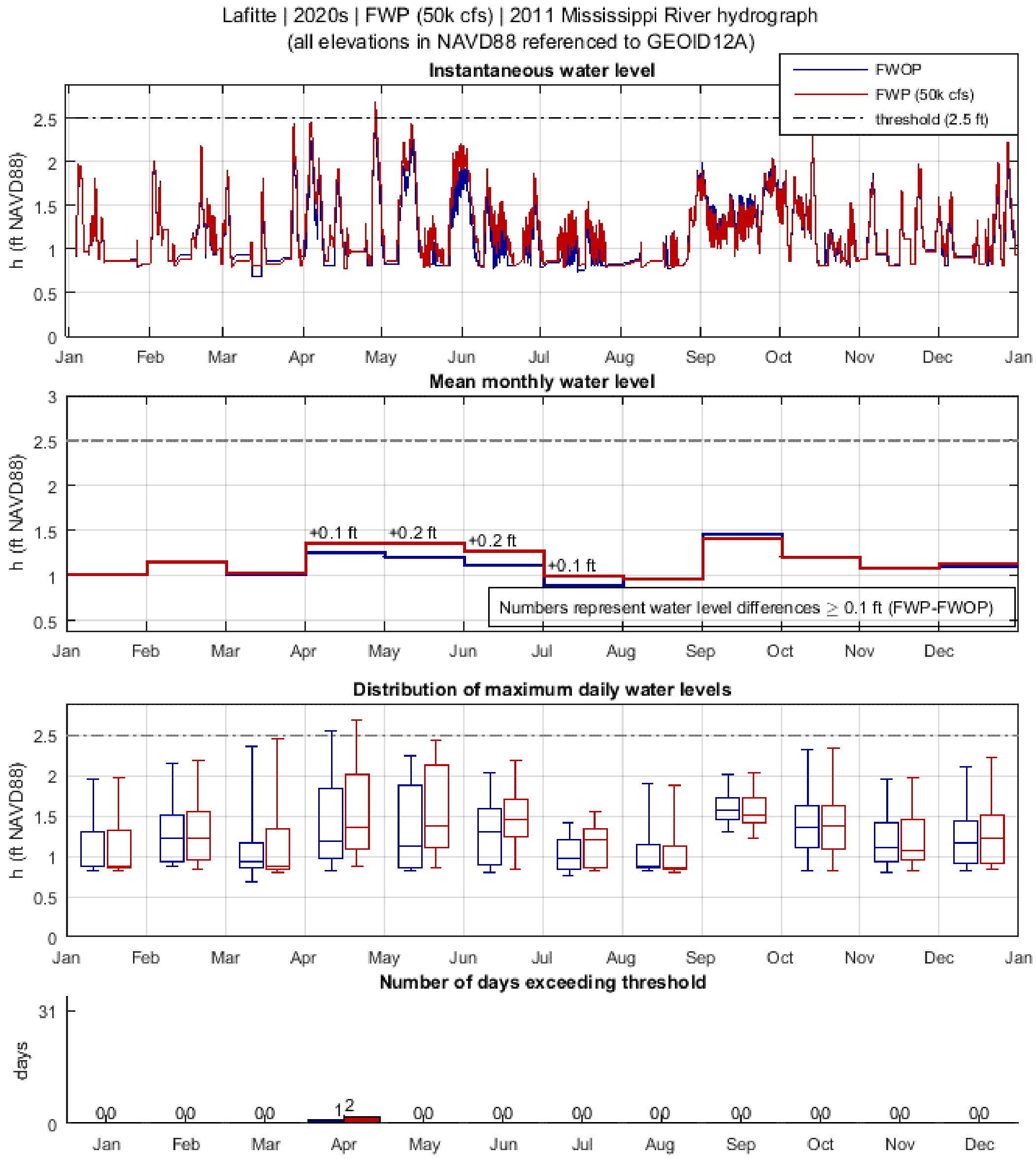


Figure C 2: Analysis of diversion impact on WSEs at Lafitte during the 2020s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

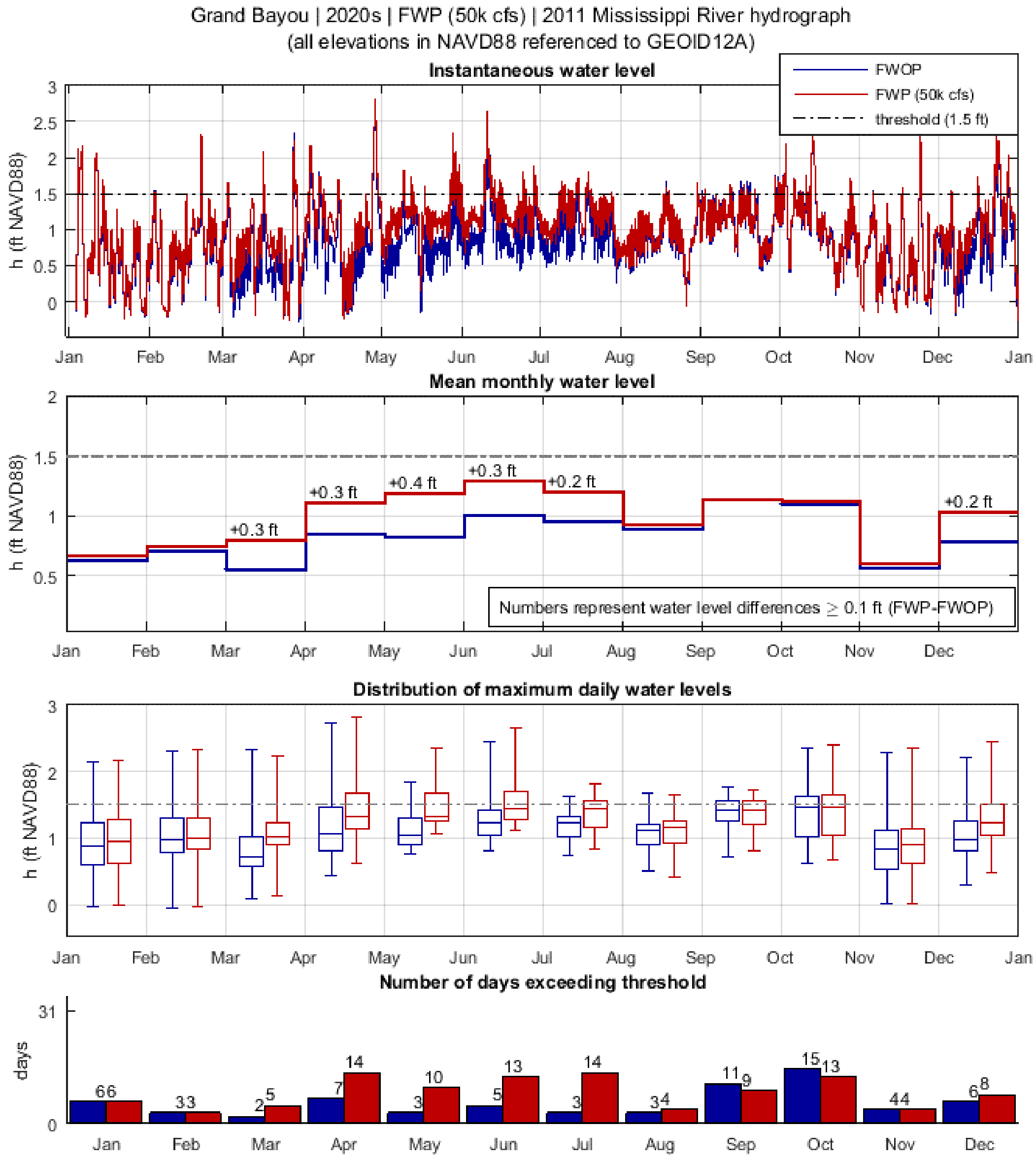


Figure C 3: Analysis of diversion impact on WSEs at Grand Bayou during the 2020s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Medium-term

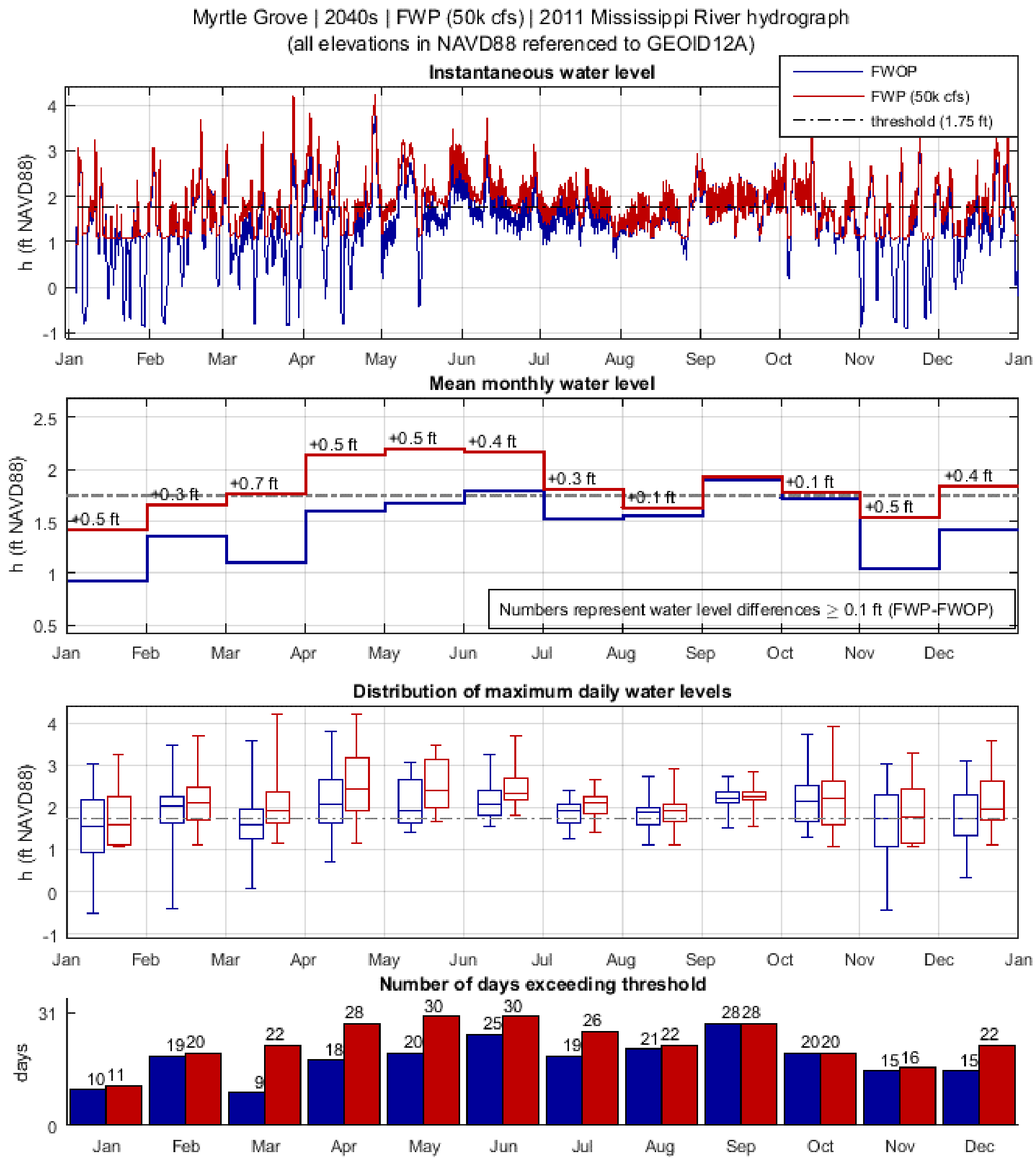


Figure C 4: Analysis of diversion impact on WSEs in Myrtle Grove during the 2040s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

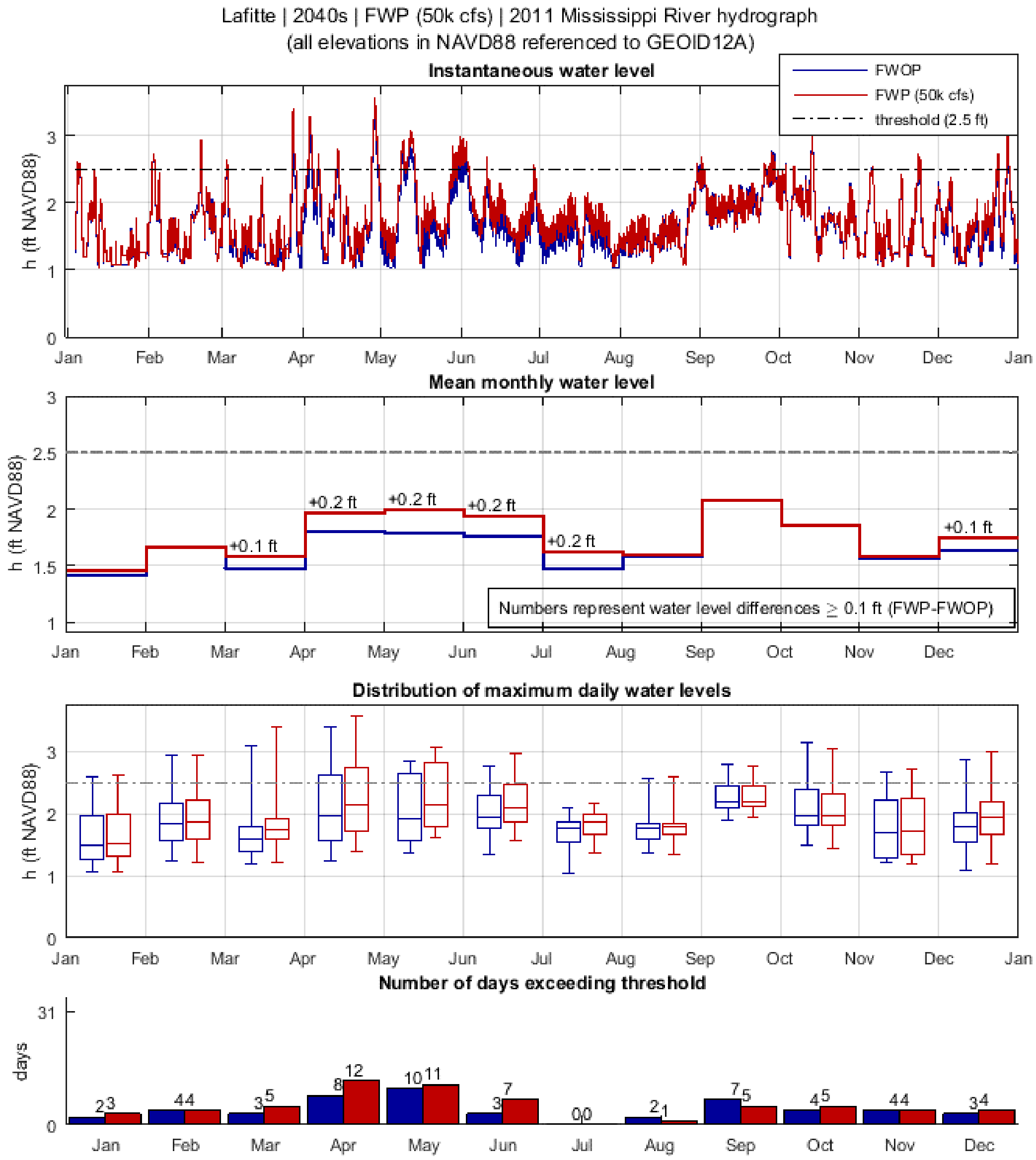


Figure C 5: Analysis of diversion impact on WSEs at Lafitte during the 2040s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

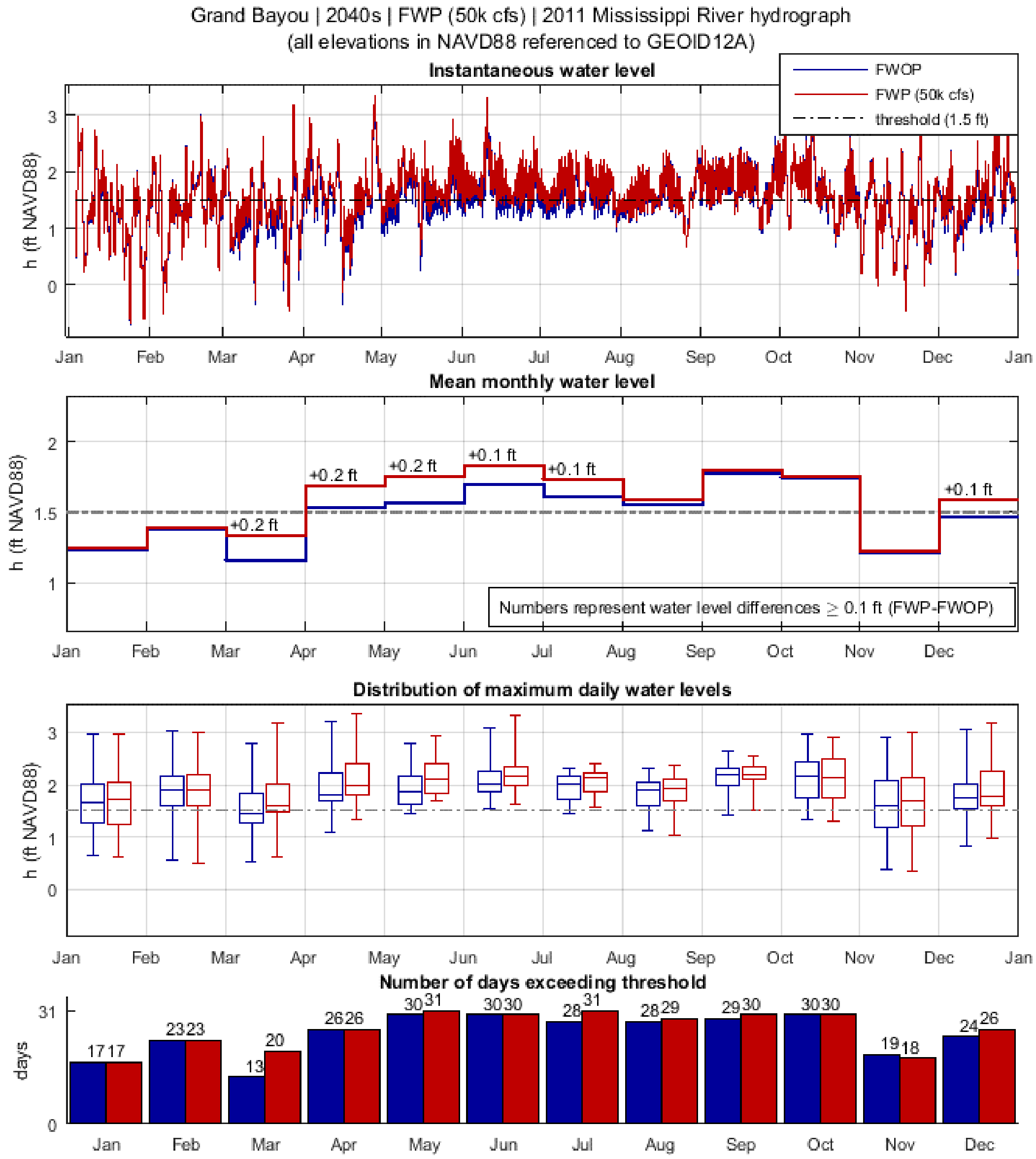


Figure C 6: Analysis of diversion impact on WSEs at Grand Bayou during the 2040s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Long-term

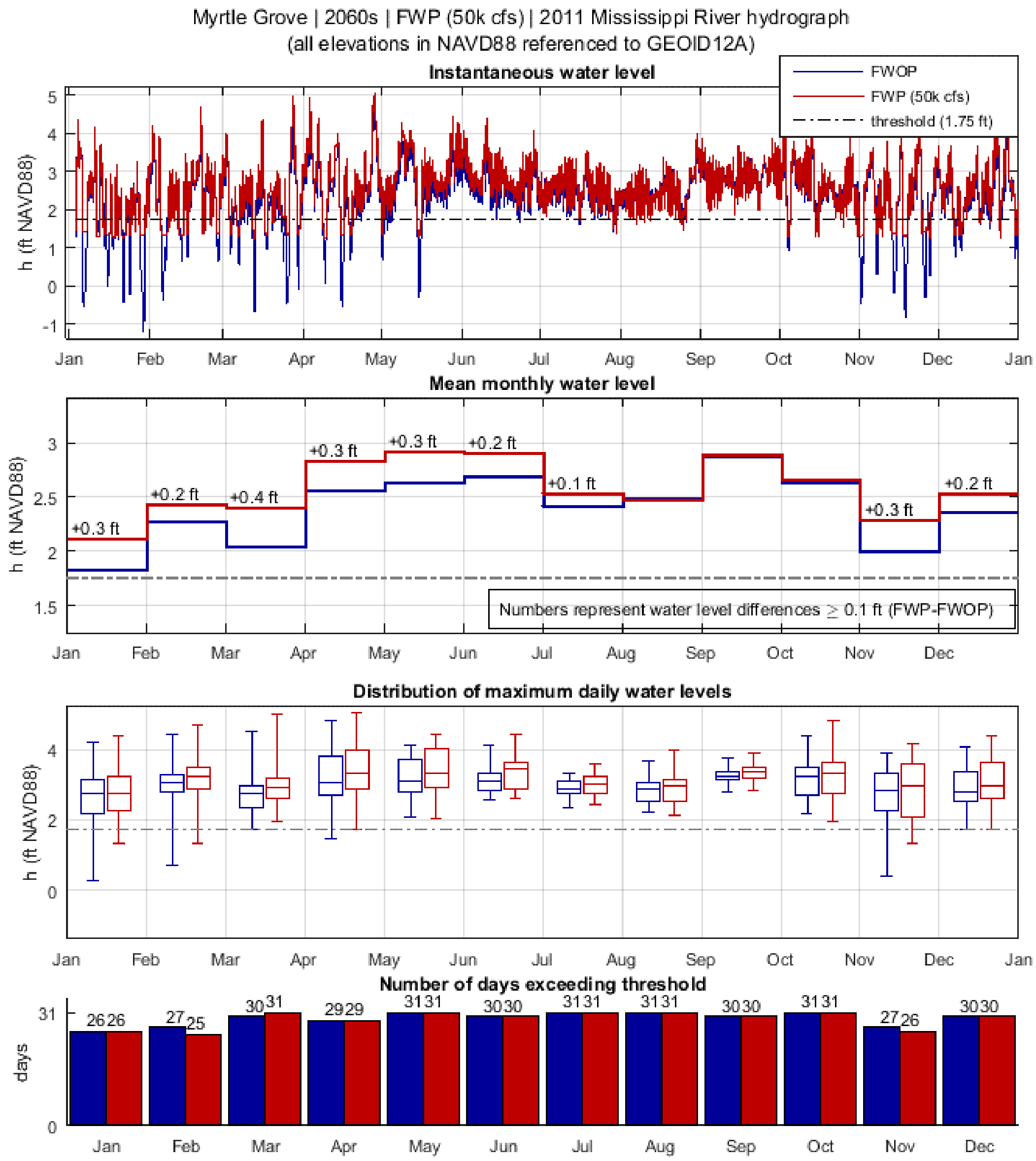


Figure C 7: Analysis of diversion impact on WSEs in Myrtle Grove during the 2060s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

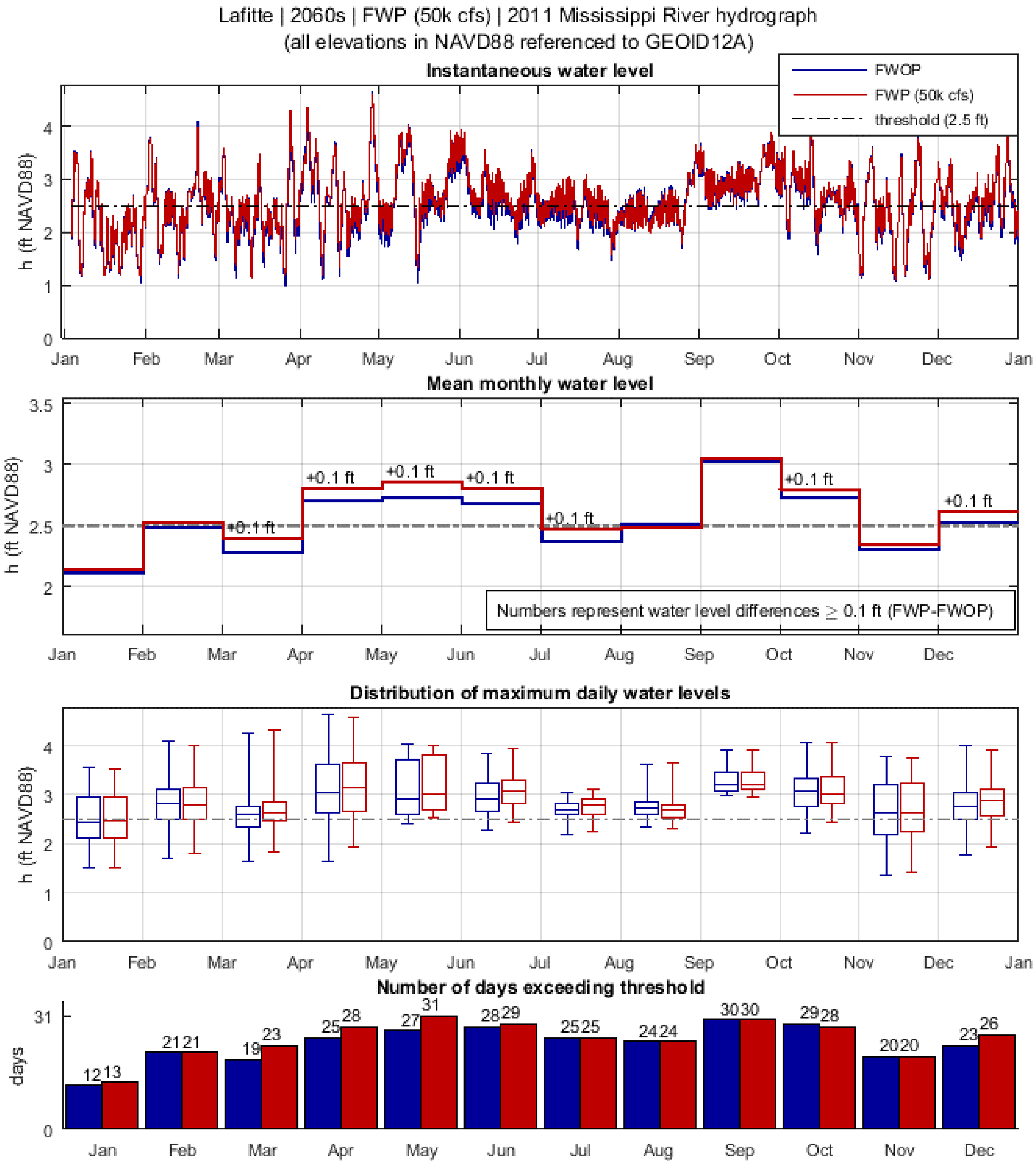


Figure C 8: Analysis of diversion impact on WSEs at Lafitte during the 2060s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

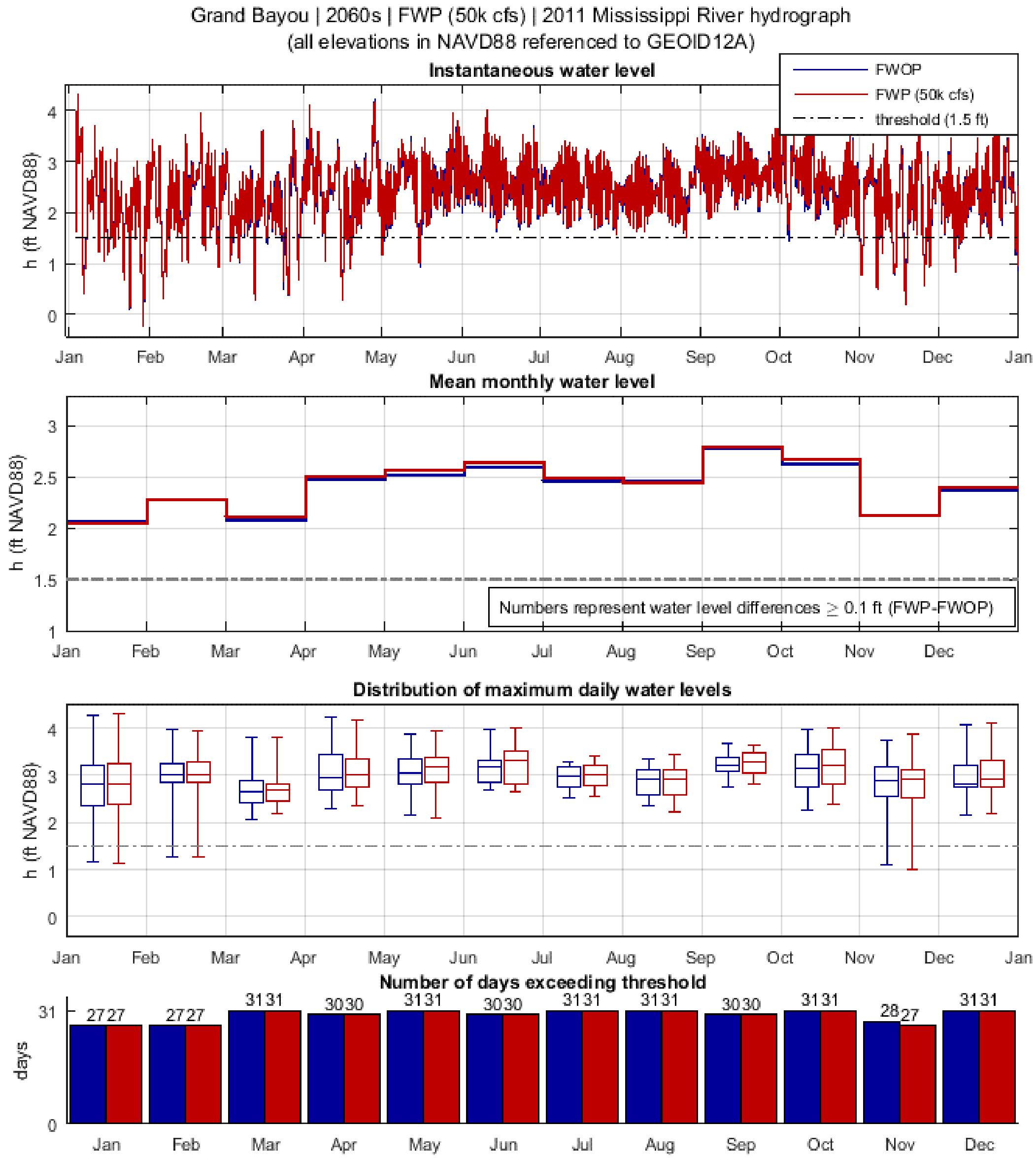


Figure C 9: Analysis of diversion impact on WSEs at Grand Bayou during the 2060s, FWOP and FWP (50k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

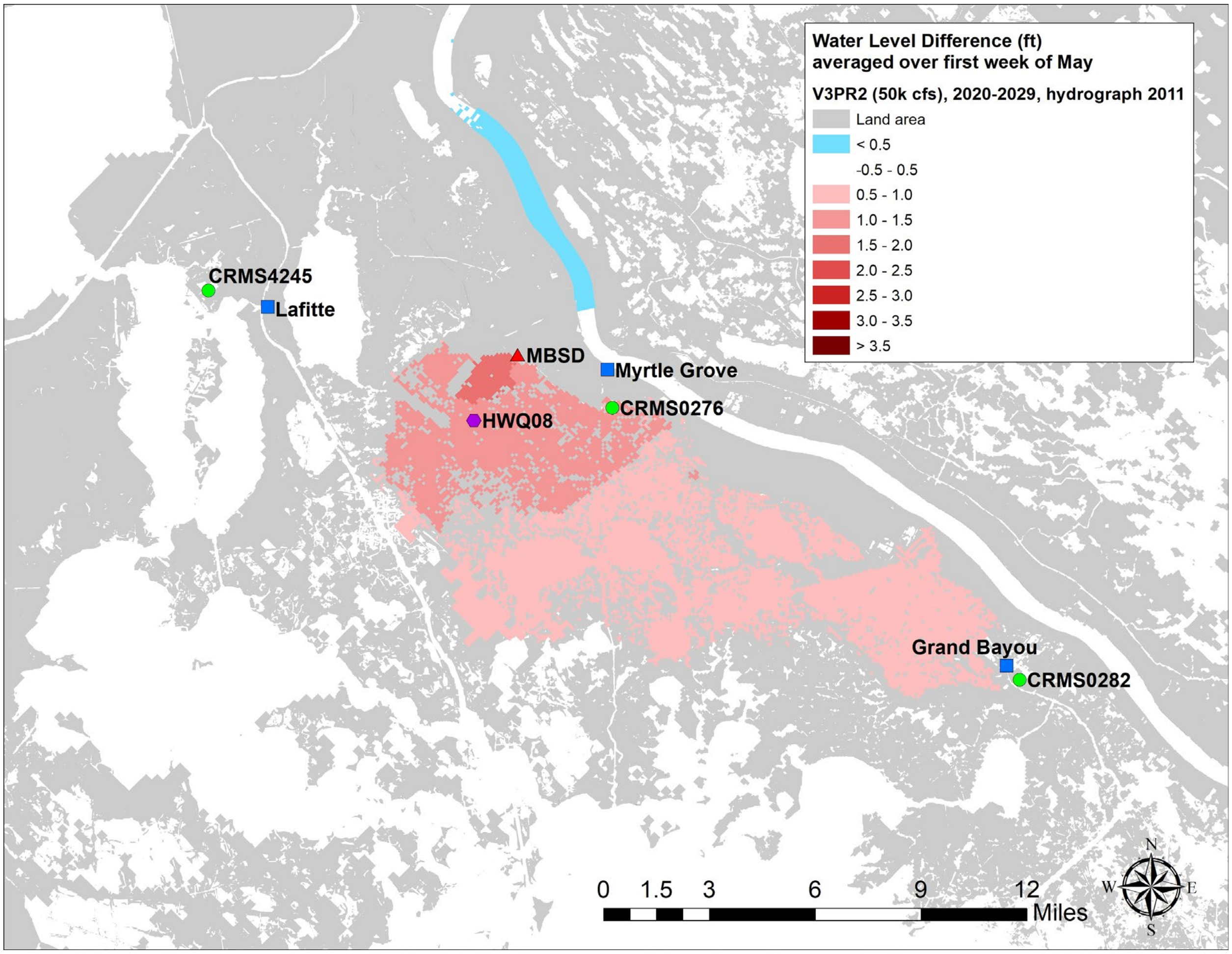


Figure C 10: Average water level difference between FWOP (V3PR1) and FWP (V3PR2, 50k cfs) for the first week of May (in the 2020s), when the diversion is at maximum capacity (50k cfs). 2011 hydrograph.

150K CFS (V3PR6) ALTERNATIVE

This section presents vertical and spatial water level analysis for alternative V3PR6 (150k cfs). A vertical analysis is presented comparing FWOP (V3PR1) with FWP V3PR6 over time.

Figure C 11 to Figure C 13 present the first decade (2020s) results (short-term analysis).
Figure C 14 to Figure C 16 present the third decade (2040s) results (medium-term analysis).
Figure C 17 to Figure C 19 present the fifth decade (2060s) results (long-term analysis).

A spatial analysis is also included to better understand how the diversion operating at fully capacity of 150k cfs would impact the WSE in the area relative the FWOP. The average water level difference for the first week of May is presented in Figure C 20.

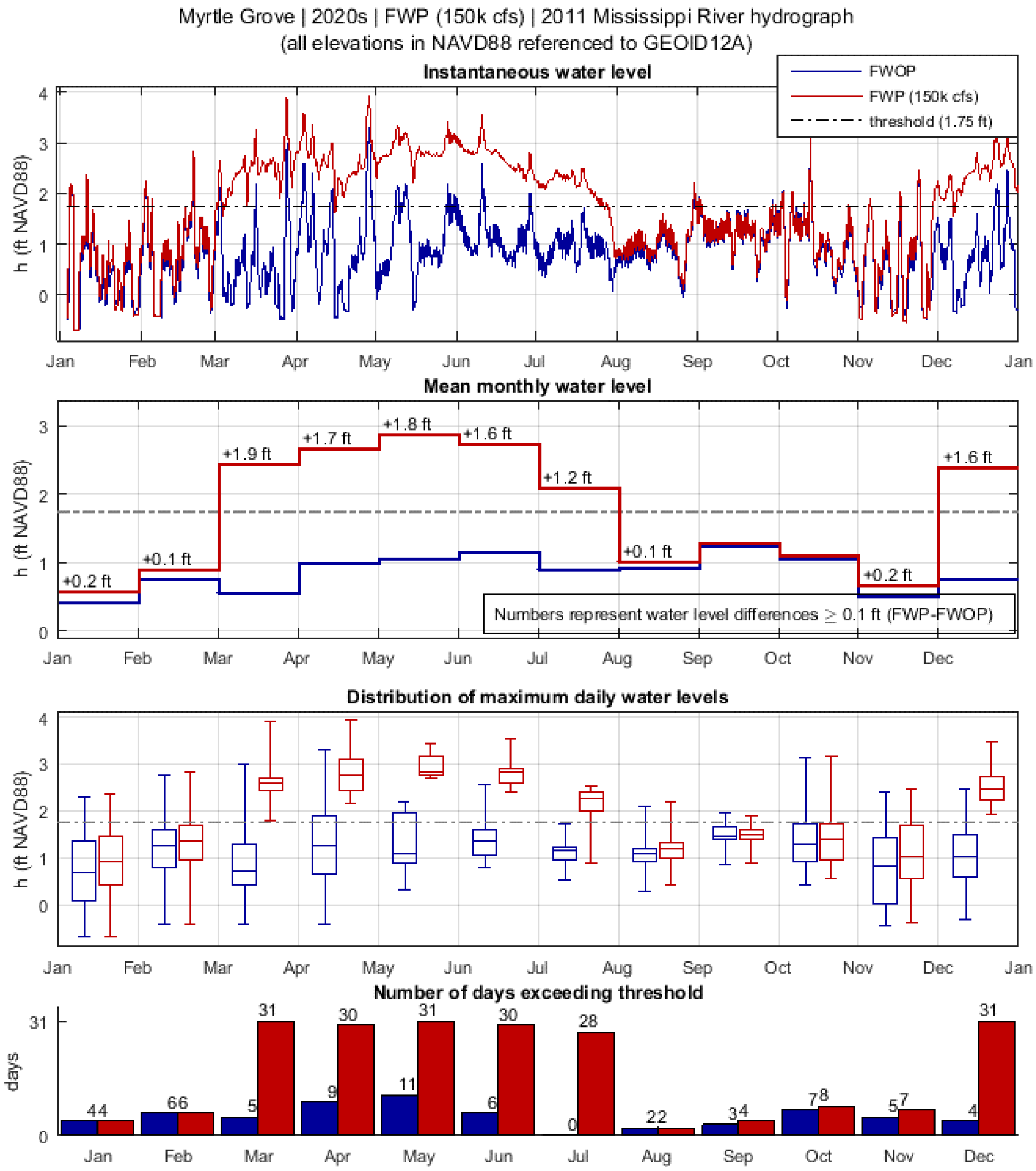


Figure C 11: Analysis of diversion impact on WSEs in Myrtle Grove during the 2020s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

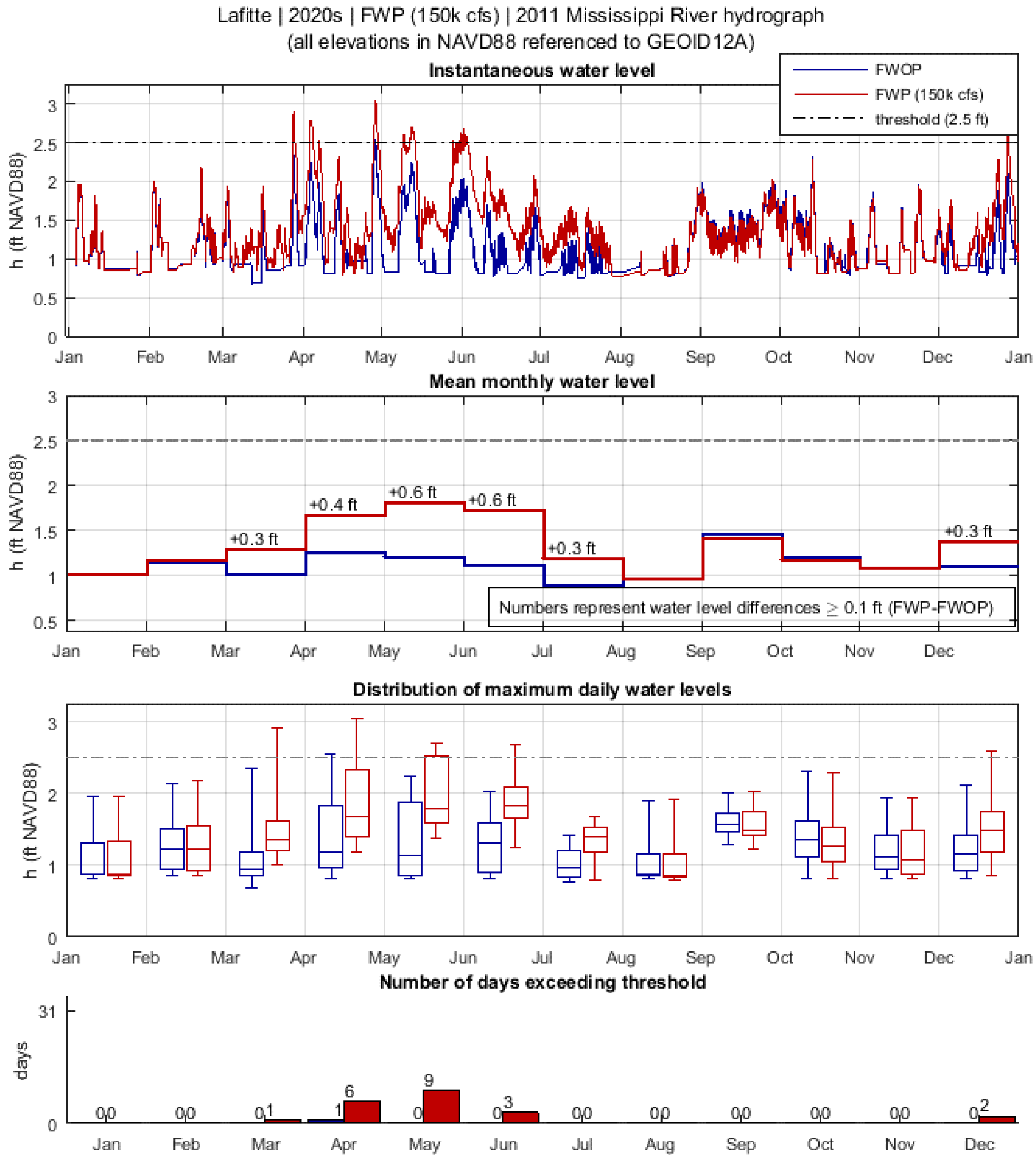


Figure C 12: Analysis of diversion impact on WSEs in Lafitte during the 2020s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

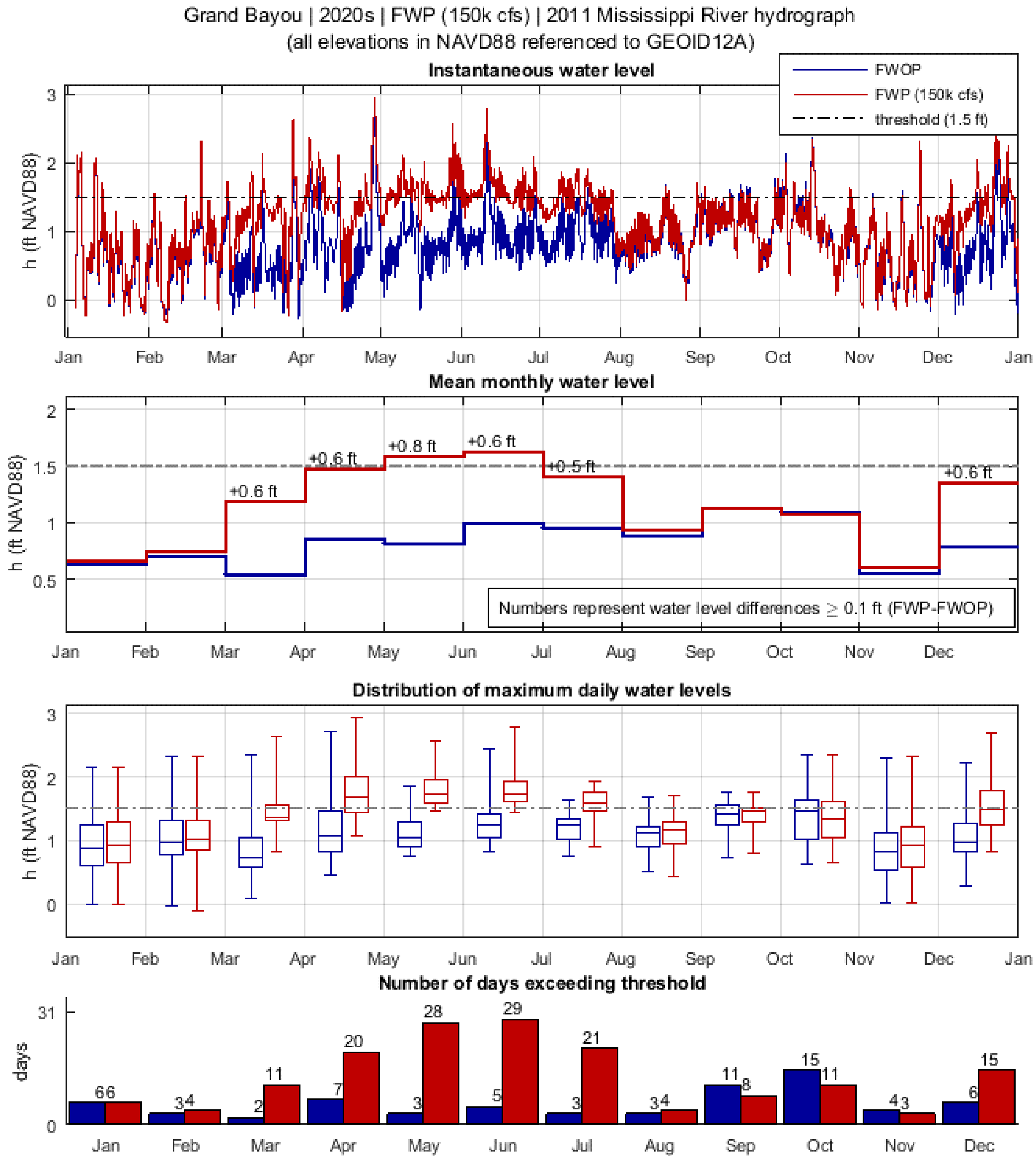


Figure C 13: Analysis of diversion impact on WSEs in Grand Bayou during the 2020s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

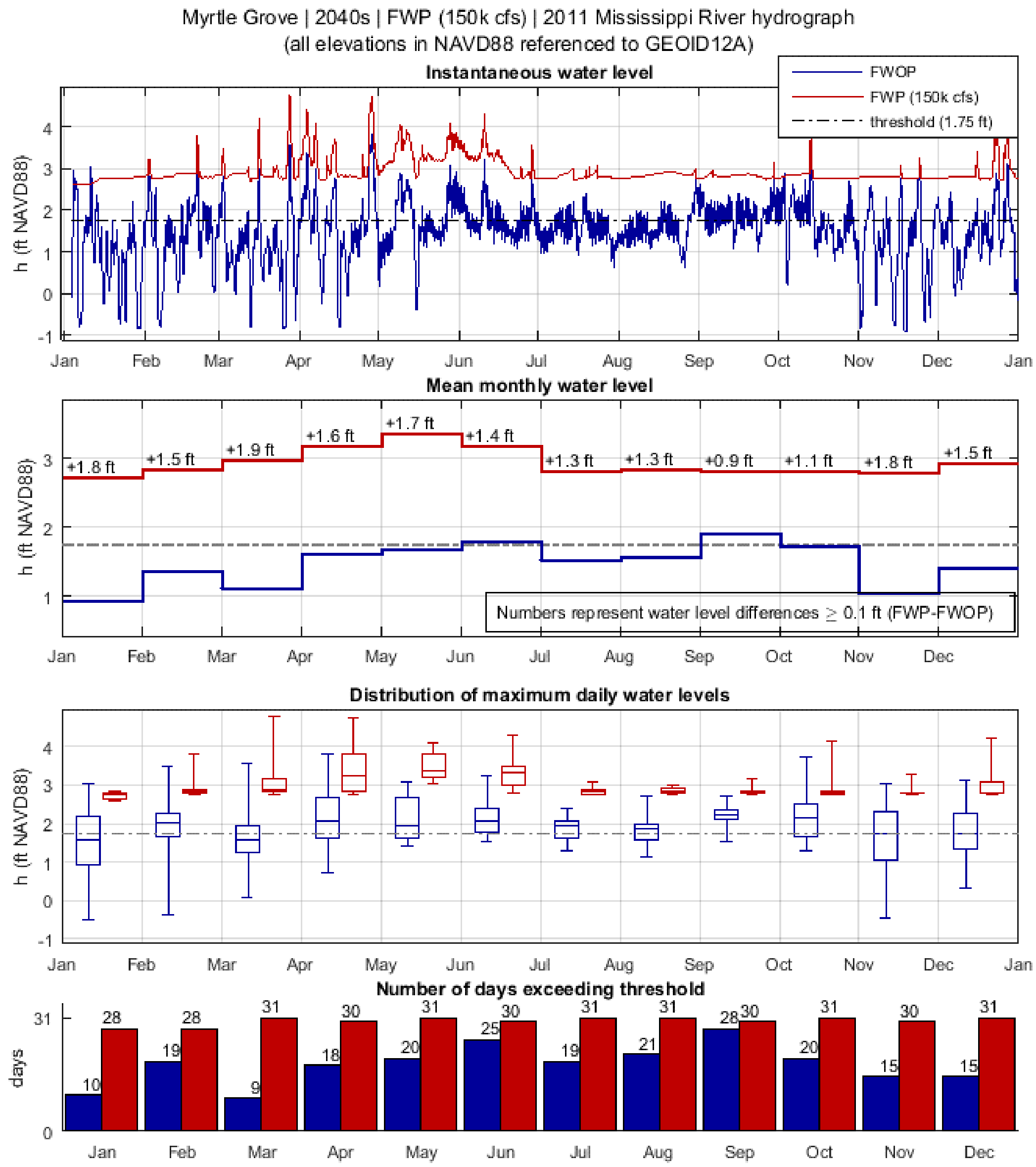


Figure C 14: Analysis of diversion impact on WSEs in Myrtle Grove during the 2040s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

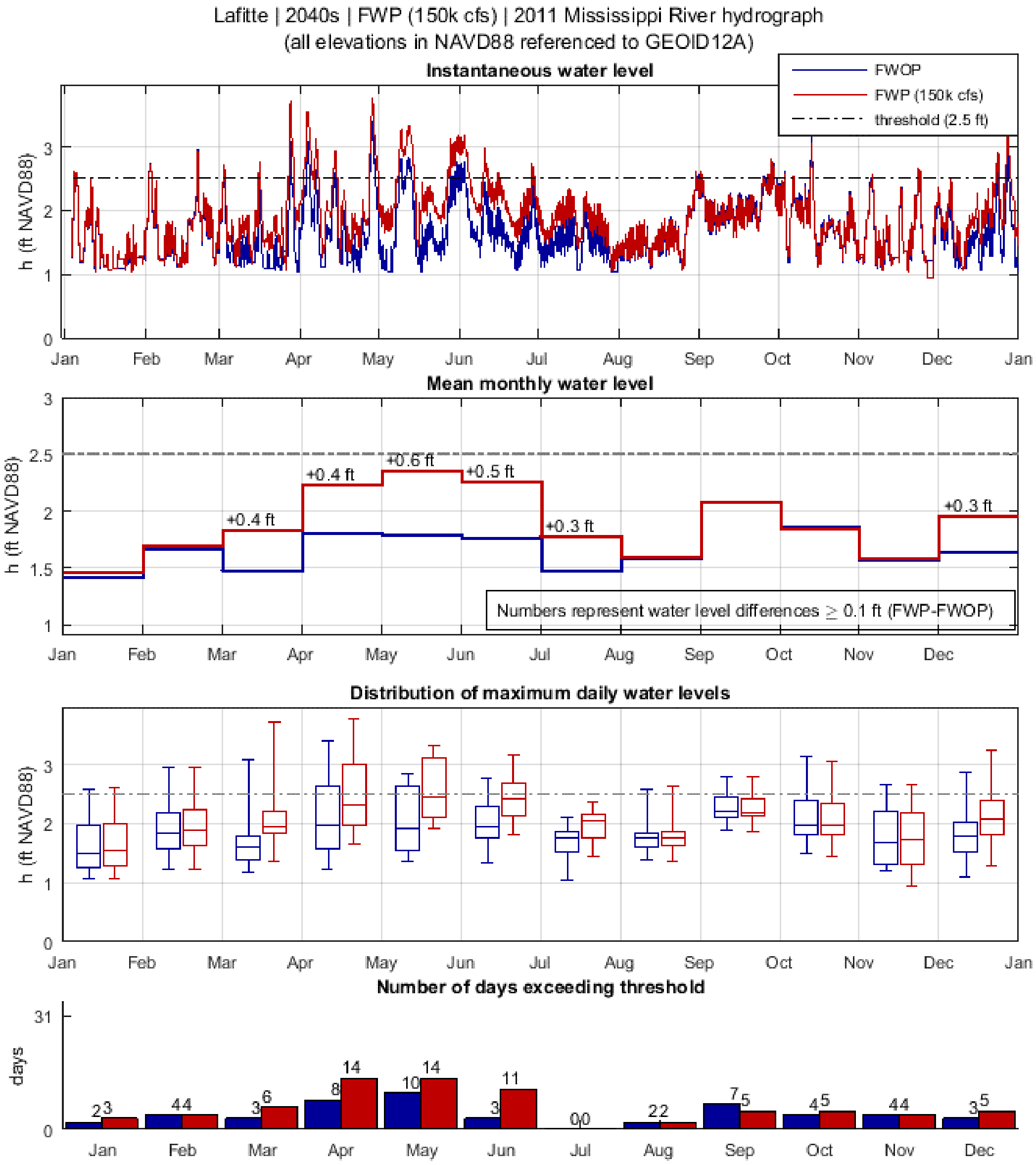


Figure C 15: Analysis of diversion impact on WSEs in Lafitte during the 2040s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

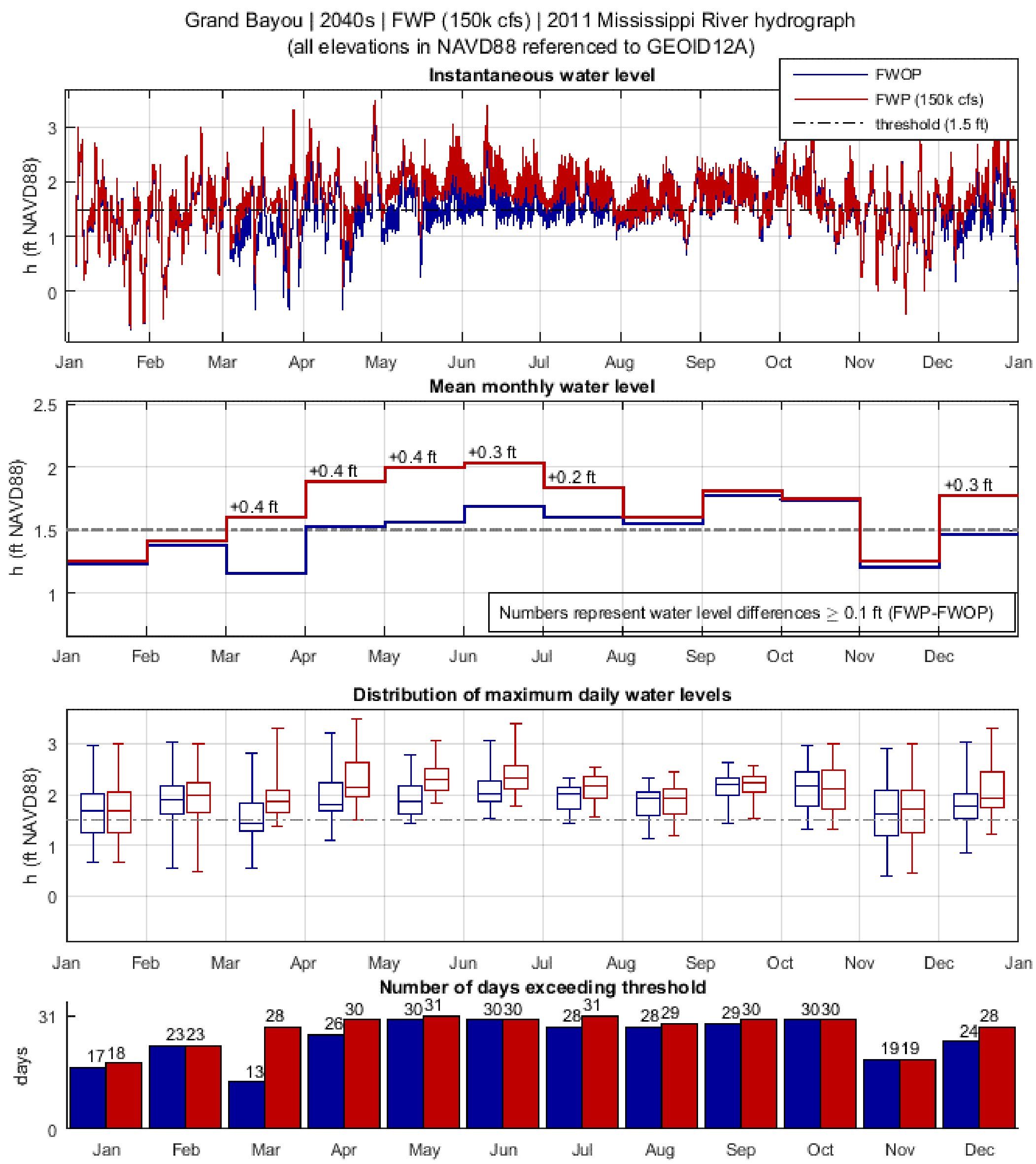


Figure C 16: Analysis of diversion impact on WSEs in Grand Bayou during the 2040s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

Long-term

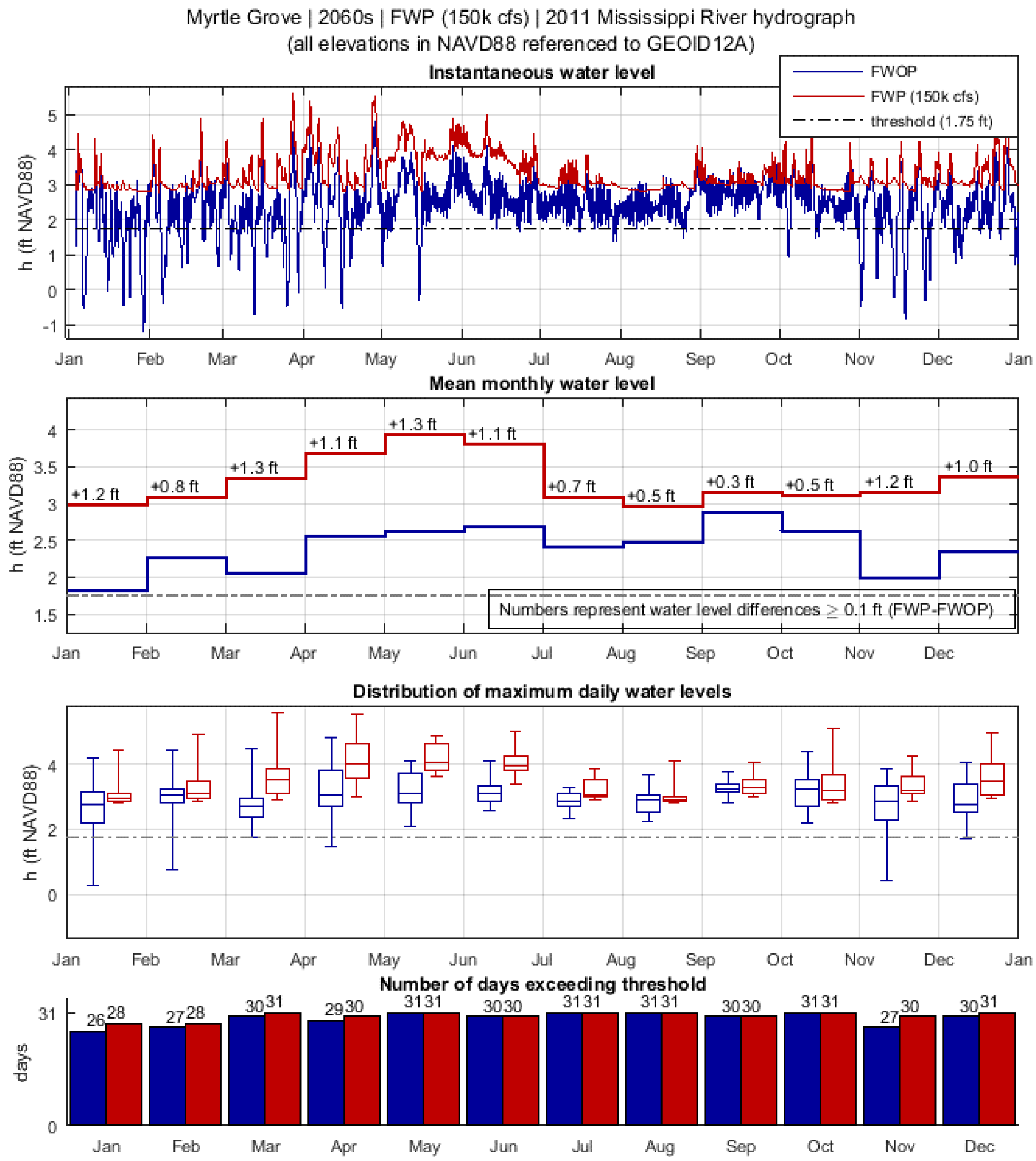


Figure C 17: Analysis of diversion impact on WSEs in Myrtle Grove during the 2060s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

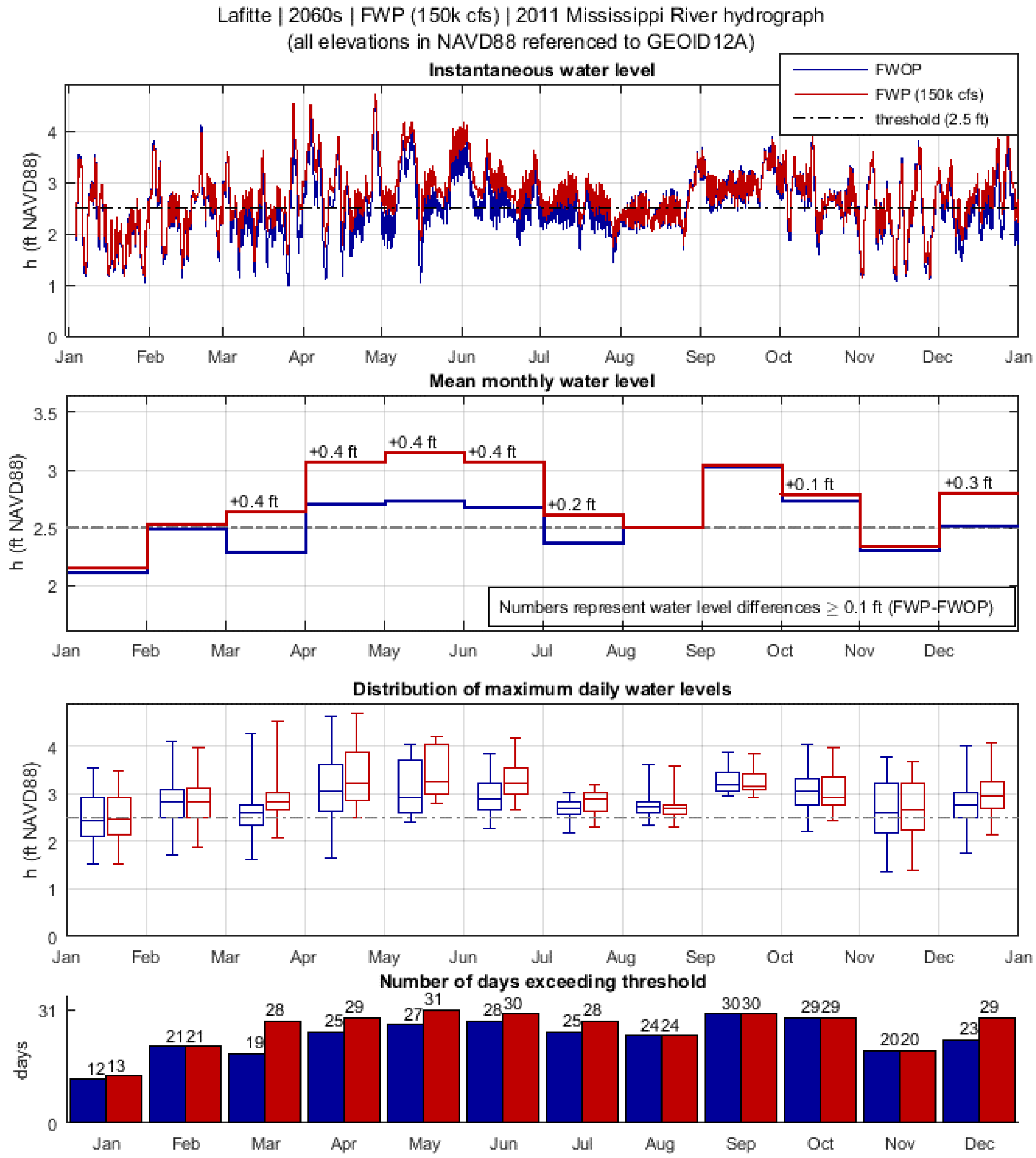


Figure C 18: Analysis of diversion impact on WSEs in Lafitte during the 2060s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

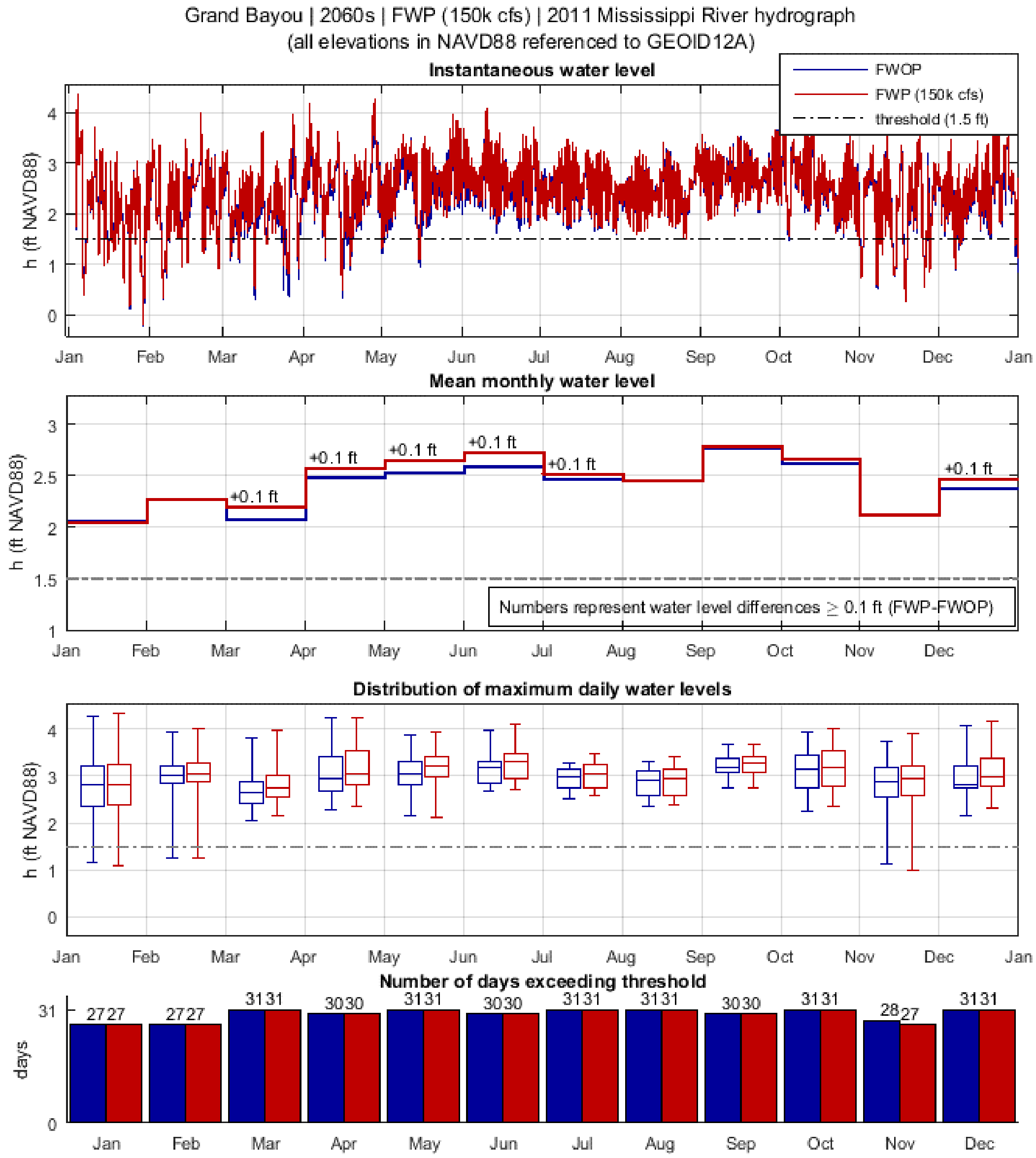


Figure C 19: Analysis of diversion impact on WSEs in Grand Bayou during the 2060s, FWOP and FWP (150k cfs), using the river hydrograph of year 2011. The top-most plot shows instantaneous water level (h). The second-from-the-top plot shows mean monthly water level (h). The third-from-the-top plot shows the distribution of maximum daily water levels (h) in box and whiskers plot format. The bottom plot shows the number of days exceeding the WSE threshold used for this community. Water level is referenced to NAVD88 (GEOID12A).

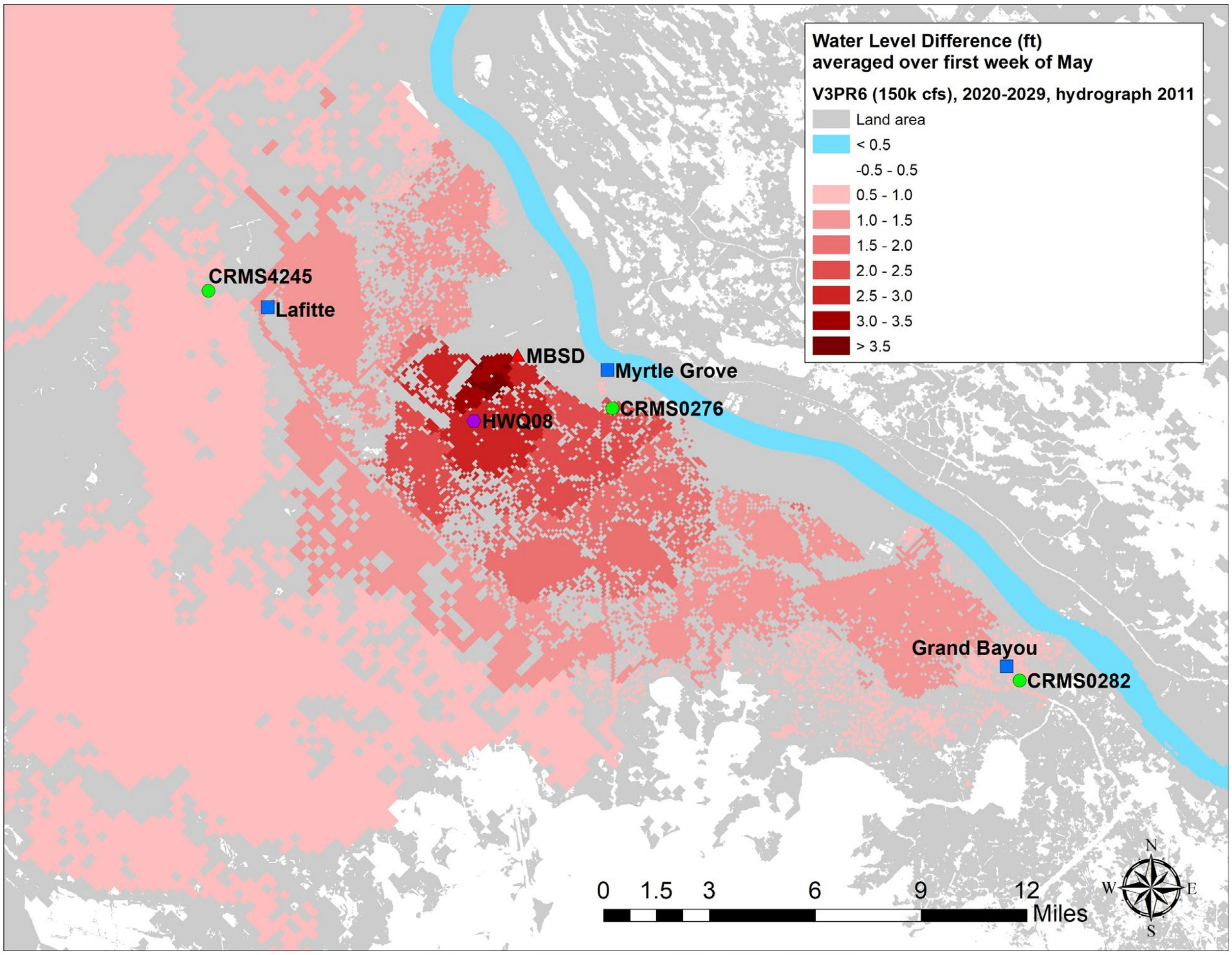


Figure C 20: Average water level difference between FWOP (V3PR1) and FWP (V3PR6, 150k cfs) for the first week of May (in the 2020s), when the diversion is at maximum capacity (150k cfs). 2011 hydrograph.